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1. Your reference	PDC/DLC/24121 01 GB
2. Patent application number *(The Patent Office will fill in this part)*	0227467.8 25 NOV 2002
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	m-spatial Limited St John's Innovation Centre Cowley Road Cambridge CB4 0WS
Patents ADP number *(if you know it)*	8309445001
If the applicant is a corporate body, give the country/state of its incorporation	~~Routing Framework~~ UNITED KINGDOM
4. Title of the invention	Routing Framework
5. Name of your agent *(if you have one)*	
"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	MATHYS & SQUIRE 100 Gray's Inn Road London WC1X 8AL United Kingdom
Patents ADP number *(if you know it)*	1081001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
	GB	GB 0201517.0	23/01/02

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	YES

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Description	70
Claim(s)	17 CF
Abstract	0
Drawing(s)	8+8

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Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	- 32 pages of Annex A in duplicate

11. I/We request the grant of a patent on the basis of this application.

Signature Mathys & Squire Date

MATHYS & SQUIRE 25 November 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

DR PAUL COZENS - 020 7830 0000

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DUPLICATE

ROUTING FRAMEWORK

The invention relates, in various aspects, to a method of and framework for providing routing information. The routing information may be provided to give a user information on a particular area, or to provide directions to the user. The routing information may be delivered to a fixed or mobile device. Other aspects of the invention relate to a method of determining the location of a device, a method of searching a database, a method of indexing geographical information, and a method of providing a service.

A first aspect of the invention provides a method of providing route information, the method comprising the steps of: storing a list of location identifiers; selecting one of the stored location identifiers; generating route information associated with the selected location identifier; and outputting the route information.

This aspect of the invention enables a list of 'favourite' locations to be stored and selected. This provides a quick and simple method of specifying a location for which route information is to be provided. The route information may be in the form of one or more graphical schematics.

Preferably the routing information or graphical schematic is output to a device, and the method further comprises the steps of: receiving a selection request from the device; and selecting the location identifier from the list in accordance with the selection request. Thus the selection may be made by a user, typically from a mobile device. The list may be stored at the device or in a central store.

Preferably the method further comprises the step of updating the list of location identifiers, for instance by way of deletion, addition or amendment.

Preferably, the step of updating the list of location identifiers comprises updating the list in response to a received update request, which preferably comprises one of: an SMS message; an MMS message; a WAP push message; an e-mail message; and a voice call to an automated speech recognition service. Alternatively or in addition, the update request may be received from a website.

Preferably, the method further comprises notifying a user that the list of location identifiers has been updated.

Preferably, the list of location identifiers is updated by adding new location identifiers which have been previously used by a user associated with the list. Alternatively or in addition, the list of location identifiers is updated by monitoring the use of each location identifier in the list, and removing less recently used location identifiers from the list. Alternatively or in addition, the list of location identifiers is updated by monitoring the use of each location identifier in the list, and removing less frequently used location identifiers from the list.

The method may further comprise the steps of (a) providing a region schematic comprising data associated with a specified region, and (b) providing at least one routing schematic indicating a route from a first location to a second location.

In a further aspect the invention provides a method of providing route information, the method comprising the steps of:

a) providing a region schematic comprising data associated with a specified region; and

b) providing at least one routing schematic indicating a route from a first location to a second location.

An advantage of this aspect of the invention is that each schematic can be customised as required.

In one example the region schematic comprises an orientation schematic and the specified region includes the first location.

In a second example said region schematic is a location schematic and the specified region includes the second location.

In a third example the region schematic comprises an overview schematic and the specified region includes both the first and second locations.

Also, by splitting a route into a number of separate schematics, this aspect of the invention is particularly adapted for use on an output device with a relatively small display screen.

Typically the first schematic and/or the routing schematic(s) are generated by a method according to any of the preceding aspects of the invention.

The method may further comprise outputting a plurality of route schematics which together provide an ordered sequence of directions from a first location to a second location..

In a further aspect the invention provides a method of providing route information, the method comprising outputting a plurality of route schematics which together provide an ordered sequence of directions from a first location to a second location.

This aspect enables a sequence of schematics to be presented (either in graphic, textual or vocal form) which guide a user between the first and second

locations. This has the advantage that a user can be presented with a sequence of relatively simple directions, without confusing the user with excessive detail.

The schematics may be output in sequential order, or may be output out of sequence order. If the schematics are output out of sequence order, then information will need to be output separately which indicates the correct sequence order required.

In most cases the first and second locations will be different locations. However in some cases the first and second locations may be the same. For instance the route may be a circular route for guiding a user past a number of tourist attractions or scenic buildings.

Typically the method further includes the step of selecting a route between the first and second locations. The route may be selected in accordance with a user preference (for instance selecting a route which is safe, or which passes a large number of tourist attractions or scenic buildings).

Preferably the method further comprises receiving a routing request, for instance from a user device or from a Location Based Service (LBS), including the first location and the second location.

Preferably the method further comprises receiving one or more route update requests, at least one of the route schematics being a route update schematic which is transmitted in response to a respective route update request.

Preferably each routing update request is received from a user device; and each route update schematic is transmitted to said user device.

The route update requests may be generated automatically, for instance by performing a network fix to monitor the current location of a mobile device,

wherein the or at least one of the schematics is transmitted in response to a change in the monitored location of the mobile device. Alternatively the route update requests may be generated in response to a user input.

Preferably the method further comprises the steps of:
selecting a sequence of said nodes which define a route between the first location and the second location; and
compiling a route schematic for each selected node.

Preferably at least one of the route schematics, typically the first schematic in the sequence, comprises a summary schematic giving an overview of directions from the first location to the second location.

Preferably the schematic is output to a hand-held device.

The plurality of route schematics may be output together as a collection of images, preferably using a messaging mechanism adapted to transmit multiple images in a single message, and may be transmitted in an MMS message.

The method may further comprise the steps of (a) receiving a location identifier from the user input device, (b) transmitting the location identifier from the transmitter to a server, (c) receiving the location identifier at the server and (d) determining the location of the device at least partially on the basis of the received location identifier.

In a further aspect the invention provides a method of determining the location of a device, the device including a user input device and a transmitter, the method comprising the steps of:
receiving a location identifier from the user input device;
transmitting the location identifier from the transmitter to a server;
receiving the location identifier at the server; and
determining the location of the device at least partially on the basis of the received location identifier.

This aspect of the invention provides a 'manual' method of determining the location of a handset. This manual method can provide a location fix more accurately and quickly than some conventional 'automatic' network fix methods.

Preferably the device is a hand-held device.

Preferably the method further comprises the step of performing a network fix on the device, and determining the location of the device on the basis of the network fix and the received location identifier.

Preferably the method further comprises the steps of:
transmitting a plurality of possible locations to the device;
presenting the possible locations to the user;
receiving a location selector from the user input device, the location selector identifying one of the possible locations;
transmitting the location selector from the transmitter to a server;
receiving the location selector at the server; and
determining the location of the device on the basis of the received location selector. Thus the amount of user input required is minimised.

In one example the location identifier comprises a sequence of one or more letters, and the method further comprises selecting a plurality of possible locations each including the sequence of one or more letters. In another example the location identifier comprises a location category, and the method further comprises selecting a plurality of possible locations each falling within the location category. These are particularly convenient methods of prompting user input.

The possible locations may be presented to the user in graphical form and/or in textual form.

In a further aspect the invention provides a method of searching a database, the method comprising the steps of:

a) searching the database to identify a number of database entries each including a sequence of *X* letters;

b) determining whether the number of database entries identified in step a) exceeds a predetermined maximum;

c) if the number of database entries identified in step a) is less than or equal to a predetermined maximum, then

i) transmitting the value *X* to a user input device,

ii) receiving a sequence of *X* letters from the user; and

iii) searching the database to select one or more database entries each including the input sequence of *X* letters; and

d) if the number of database entries identified in the step a) is greater than the predetermined maximum, then repeating steps a) and b) with a greater value for *X*.

This aspect provides an 'X-letter' search mechanism which can be customised to suit a particular screen size (by varying the maximum number of database entries permitted).

In a further aspect the invention provides a method of providing route information, the method comprising receiving input data; receiving area constraint data; querying a data source with the input data and the area constraint data; outputting the results of the query; receiving a selection identifying one of the output query results; generating a route information in accordance with the selection; and outputting the route information.

Preferably, generating route information comprises generating at least one route schematic.

This aspect of the invention enables a user to enter a limited search query which returns a set of results for further selection. The invention is particularly suited where it is difficult for the user to enter a complex search query (for instance if the user is using a limited keyset on a mobile phone).

In a further aspect the invention provides a method of providing routing information, the method comprising associating a plurality of locations or routes with respective codes; storing the codes in a data source; receiving input data; selecting one of the locations or routes by querying the data source with the input code; generating a schematic of the selected location or route; and outputting the schematic.

This aspect enables the codes to be advertised publicly – for instance on advertising billboards – and input by a user who wishes to receive the schematic. This greatly simplifies and speeds up the input/search process.

Each code may be associated with a single location only. In this case, the location may be used simply to identify a location for which the user requires a schematic. Alternatively the single location may be used as a start or end point in a routing application. Alternatively the code may be associated with a route. The route may have different start and end points, or a single start/end point (that is, a circuit route).

In a further aspect the invention provides a method of providing a service, the method comprising receiving a message, the message including a user identifier and a search term; logging a user into the search service using the received user identifier; querying a data source using the search term; and outputting the results of the query to the user.

An advantage of this aspect is that the user can both log onto the service, and have a search performed, by sending only a single message. Typically the

message is in a format selected from SMS, MMS, WAP push, a voice call to an automated speech recognition service, or email.

In a further aspect the invention provides a method of providing a service, the method comprising receiving a message; allocating a service resource to a user in response to the message; and outputting a service resource locator to the user to enable the user to access the service resource.

This aspect provides a particularly convenient method of allocating a service resource, and notifying the use. Typically the resource locator is a Uniform Resource Locator (URL) address.

In a further aspect the invention provides a method of providing route information to a known end point, the method comprising querying a data source with the known end point to identify a start point near the known end point; generating route information from the identified start point to the known end point; and outputting the route information.

This aspect enables a user to be provided with route information without requiring the user to define the start point of the route. This may be of use in a case where the user is unsure of their preferred start point.

Thus for example, the identified start point may fall within some defined category: for instance the start point may be a transport nexus such as a railway station, underground station, bus station, bus stop or public car park. Alternatively, the user may be provided with a tourist route past a series of tourist attractions, terminating at the specified end point.

In a further aspect the invention provides a method of providing route information from a known start point, the method comprising querying a data source with the known start point to identify an end point near the known start

point; generating route information from the known start point to the identified end point; and outputting the route information.

This aspect enables a user to be provided with route information without requiring the user to define the end point of the route. This may be of use in a case where the user is unsure of their preferred end point.

In a further aspect the invention provides a method of providing route information, the method comprising outputting one or more route directions along a route between a start point and an end point; receiving an indication that a user following the directions has become lost; identifying one or more points on or near the route; outputting the identified point(s) as options to the user; receiving a selection of one of the options from the user; and outputting one or more route directions from the selected point to the end point.

An advantage of this aspect is that it does not require a user to go through a complete "location selection" routine if they become lost. Instead, the user is presented with a number of options on or near the route.

In a further aspect the invention provides a method of providing route information, the method comprising defining one or more desired locations; and outputting a plurality of route schematics which together provide a circuit route which starts and ends at the same point and includes each of the desired locations.

This aspect is particularly suited for use by a tourist in an unknown location – providing a circuit route for instance via a series of tourist attractions.

In a further aspect the invention provides a method of determining the location of a mobile device, the method comprising the steps of:

a) obtaining a coarse location fix defining a geographical area;

b) querying a data source to select points of interest which are located within the geographical area defined by the coarse location fix and which have stored criteria which indicate that the points of interest are likely to have a visibility to a user on the street which lies above a preset threshold;

c) outputting the selected point(s) of interest as options to the mobile device;

d) receiving a selection of one of the options from the mobile device; and

e) determining the location of the device at least partially on the basis of the selection received from the mobile device.

This aspect can reduce the number of options which are provided to a user in a manual location fix, by only providing points of interest which are likely to be visible to the user.

A further aspect provides a method of indexing geographical features comprising splitting a map into a non-uniform grid of tiles, each tile includes a list of features located in the geographical area represented by the tile.

An advantage of this indexing scheme is that it is easy to quickly access all the information relating to a specific geographical area

A further aspect of the invention provides a method of providing route information, the method comprising receiving a request containing coordinates of a desired destination, generating one or schematics which provide directions from a start location to the desired destination, and outputting the schematic(s).

This invention provides a quick and easy method of identifying a desired destination, by using coordinates (such as latitude and longitude).

In a further aspect the invention provides a system for guiding a user along a route to a specified route end point, the system comprising:

a. a central server capable of calculating routes through a transport network between specified start and end points and delivering routing instructions to and receiving input from

b. a mobile client device by some means of interactive communication such as a WAP session where the client must:

   i. receive information including routing instructions,

   ii. display such information to a user and

   iii. communicate user input back to the central server

c. wherein, once both the route start point and route end point have been communicated to the central server, the central server delivers routing instructions that allow the user to advance along the route and then indicate they have done one of the following:

   i. reached the route end point

   ii. followed the routing instruction and require another one

   iii. become lost

Typically the user identifies a route end point by:

a. selecting from a menu of locations displayed on the mobile client, the menu being built from a personalised list of locations held on the central server which is communicated to the client device

b. in the case that a route start point has already been set, asking the central server to provide a list of places of interest near to the route start point and selecting one of them

Alternatively the user may identify a route start point by:

a. selecting from a menu of locations displayed on the mobile client, the menu being built from a personalised list of locations

held on the central server which is communicated to the client device

b. inputting a code visible to the user from their current location that the central server can map onto a location

c. in the case that a route end point has already been set, asking the central server to provide a list of transport nexuses near to the route end point and selecting one of them. A transport nexus could, for example, be any of the following:

    iv. a railway station
    v. an underground station
    vi. a bus station or bus stop
    vii. a public car park

Typically the central server divides the route into sections so that it can generate a routing instruction for an individual section such that the user:

a. needs only that instruction to advance along that section of the route
b. can identify when they have advanced along that section of route
c. can verify that they are already at the start of the section, that is identify if there is a discrepancy between where the central server considers the user to be and where the user actually is, and so determine whether the user has become lost

If, during the guiding process, the user indicates that they have become lost the central server determines a set of locations representing nodes in the transport network that are near to nodes which have already been traversed in the route. The server communicates these locations to the client device, where they may be presented as a menu, and the user indicates which of these represents their current location, allowing the process to repeat with a new route start point having been specified. The menu of locations representing the nodes in the transport network identified above may be

built from the names associated with points of interest that can be associated with the individual locations. These are obtained by looking for points of interest with a high significance within a specified radius of the location. The point of interest with the highest significance is used to represent each location, unless points of interest with the same name, irrespective of their significance, have been identified for two or more locations in the set, in which case they are all removed from consideration.

Once a route start point and route end point have been communicated to the central server, the central server may provide a summary of the route to the user prior to starting the guiding process. This may include information such as the length of the route and the estimated time it would take to walk it. If the user selects to be 'guided' along the route, the route start and end points are added to the personalised list of locations. In addition this personalised list maintains a count of how often an individual location has been used as a route start point and as a route end point.

When generating a routing instruction the central server may make use of information specific to that user to provide better tailored instruction. For example:

a. because the instruction is generated in near 'real-time' the central server may use information about the current time and location of the user together with the opening times of 'places of interest' to help determine what might represent a suitable landmark.
b. the central server may use locations from the user's personalised list of locations, especially those that have been used frequently as a start point or end point of a route, as landmarks.

In a further aspect the invention provides apparatus including features for performing the method steps described above in any aspect of the invention. Typically the apparatus is in the form of an appropriately programmed

computer. In a preferred example the apparatus is in the form a central server remotely located from a user, where the user may be a Location Based Service (LBS) and/or a mobile client device. The central server is typically configured to generate and output schematics to the LBS and/or mobile client device. The mobile device (typically a hand-held device) is appropriately configured to receive and present schematics (typically in graphical form) to a user.

The invention also provides a computer program and a computer program product for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein, and a computer readable medium having stored thereon a program for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein.

The invention also provides a signal embodying a computer program for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein, a method of transmitting such a signal, and a computer product having an operating system which supports a computer program for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein.

Features implemented in hardware may generally be implemented in software, and vice versa. Any references to software and hardware features herein should be construed accordingly.

Any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, method aspects may be applied to apparatus aspects, and vice versa.

Preferred features of the present invention will now be described, purely by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic drawing of the basic system hardware;

Figure 2 is a schematic drawing of the software architecture;

Figure 3 is a schematic drawing of a location and guidance service;

Figure 4 is a flow diagram summarising the routing system;

Figure 5 is a flow diagram illustrating a preferred method of performing a location fix;

Figure 6 illustrates components of a system for adding an entry to a MyPlaces list;

Figures 7-15 are exemplary screenshots for a small screen device; and

Figures 16-20 are exemplary screenshots for a large screen device.

1. Overview

1.1 Architecture

A basic system hardware architecture is shown in Figure 1. A location/guidance server 1 is connected to a database 2 and communication network 3. The communication network 3 communicates with a mobile device 4 via a wireless link. A Location Based Service (LBS) server 10 is also connected to the communication network 3..

1.1.1 Mobile Device

Mobile device 4 is typically a hand-held device such a mobile phone or personal digital assistant (PDA). The mobile device 4 may have a significantly smaller screen, lower data transfer rate and more limited user interface than is found in equivalent browser/hardware arrangements for the fixed Internet. Two different classes of mobile device are considered here (though in other embodiments, different kinds of devices may be used): small devices and medium devices.

Small and medium devices differ in certain characteristics, including screen resolutions, colour / monochrome displays and user interaction methods. For example, smaller devices such as Wireless Application Protocol (WAP)-enabled mobile telephones (one example being the Siemens S45 mobile phone) would typically have small, monochrome displays, using standard mobile telephone keys and WAP menus for user interaction. Medium size devices may have slightly larger screen resolutions (typically no less than 120 x 120 pixels) and may have colour displays. An example of such a device is the Trium Eclipse mobile phone. The information generated for small and medium devices is generally different and takes into account the different characteristics of the devices.

The approach taken for medium size devices is also applicable to larger devices such as the Compaq Ipaq or Nokia 9210, which typically have larger resolution colour displays and use a point-and-click interface, which may be operated using a stylus. Therefore, "medium devices" shall be taken to include such devices. In fact, techniques described for small and medium devices may be applied to devices of any size. Furthermore, according to user preference, schematics described below for medium devices can be used on small devices, particularly if limited to a view of a single junction.

The mobile device 4 may also be a General Packet Radio Service (GPRS) device.

In some embodiments, certain aspects of the routing service may be accomplished by executing software on the mobile device. For example, the mobile device may comprise a Java virtual machine or a browser capable of executing scripts in languages such as JavaScript.

1.1.2 Server

The location/guidance server 1 comprises software modules for location identification and for the generation of routing information such as route schematics as well as interfaces to users of the location/guidance server and to database 2.

Schematics

The information provided by the server 1 is generally in the form of *schematics*. In some cases the schematics may be non-graphical: for instance in the form of textual or voice data. However in most cases the schematics include graphical information in the form of simplified maps, and are derived from conventional mapping and geographical data. Graphical schematics may be in formats including bitmap, Joint Photographic Experts Group (JPEG), Graphic Interchange Format (GIF), Portable Network Graphics (PNG) or a vector graphics format. Schematics may be transmitted to the mobile device by standard protocols such as WAP or Hyper Text Transfer Protocol (HTTP), or by a proprietary protocol.

The schematics include only such information as is useful and necessary for a routing task, or other task. For example, schematics typically include representations of road layouts along with context information, such as prominent buildings or landmarks. Context information of this kind will be referred to as *Points Of Interest*, or *POIs* in abbreviation.

Schematics are commonly labelled with textual information to help the user recognise the various features.

Routing Schematic Types

Various types of schematic are available, each with a specific role in the routing / guidance process. There are three major types of schematics: orientation schematics, location schematics and routing schematics.

Orientation schematics assist users to find their current location before following a route. Location schematics are similar to orientation schematics but are not related to a route; they simply provide an overview of a geographical area.

Routing schematics indicate the correct route to the user using symbols such as arrows or by highlighting the required roads. Routing schematics can be further classified as junction and non-junction schematics. Junction schematics indicate how a user should proceed at a junction of two or more roads. Non-junction schematics illustrate landmarks along sections of the route that do not contain major junctions, to allow the users to gauge their progress along the route.

Routing schematics typically represent part of a route; but overview schematics may be provided which describe a route in its entirety.

The nature of the routing schematics that are generated is in part dependent upon the functionality of the mobile device 4. In general, more detailed routing information can be displayed on large and medium mobile devices than on small mobile devices.

Instead of presenting the user with a graphic schematic, the device may present information in the form of text only, and/or as a synthesised voice.

The routing service generates the most appropriate form of schematic based on knowledge of the mobile device, which may be stored in a database of user

information or may be transmitted by the device with each routing request or at the start of each routing session.

Small Screen Routing Schematics

For devices with small screens, the routing schematics are typically:

- *Junction schematics:* at junctions, either a detailed, accurate view or a simplified abstract representation of the junction, along with arrows to indicate movement through the junction and points of interest to help the user work out where he is.
- *Non-junction schematics*: between junctions, a schematic of simplified road layout and key points of interest.

Depending on requirements, non-junction schematics may be omitted, and only junction schematics displayed.

Medium Screen Routing Schematics

For devices with medium screens, the routing schematics are typically:

- Consecutive schematics of sections of the route. The user steps through these as he progresses down the route.
- Each display covers multiple junctions, with routes indicated through and between each.
- Selected points of interest (landmarks, buildings, street furniture) around and between junctions are displayed.
- Most detail is displayed at the junctions. The number of junctions is generally two, but may vary.

Large Screen Routing Schematics

Like the medium screen equivalents, here more than one junction is typically shown per screen.

1.1.3 LBS

A Location Based Service (LBS) – also known as a Location Based Application or Location Enabled Application - is run on a second server 10 which is also connected to the communication network 3. The LBS is an application which uses the location/guidance services of server 1 as part of a larger application. Many examples of such applications may be imagined – one such example might be a restaurant guide which provides a user with information regarding a restaurant close to his present location, including reviews of and directions to the restaurant.

Although in a preferred embodiment, services are offered for use by LBSs, in some embodiments location/guidance server 1 may provide services, for example a complete location and routing service, directly to the mobile device via communication network 3.

1.1.4 Database

Database 2 contains geographical information used by location/guidance server 1 in the identification of locations and generation of routing information. The geographical information includes information on roads, road names and classifications, buildings and building classifications, business names and business classifications, full address data and other geographical and mapping features. In some embodiments, database 2 comprises a single homogeneous database. In the preferred embodiment, database 2 comprises several heterogeneous data sources, such as databases and files.

All the data used by the system is commercially available. There are numerous alternative sources of data in the UK, and equivalents (with different degrees of comprehensiveness and accuracy) in other countries. For example, the following different classes of data may be used for the UK:

- Large scale cartographic data (for example Ordnance Survey MasterMap). This includes building outlines (used, for example in POI calculations), and may also be used to locate features such as rivers and parkland to be represented on schematics. As will be described later, schematics typically provide junction views which are represented schematically or by displaying a small but accurately drawn extract from the cartographic data covering the junction of interest (i.e. a small map), with the outlines of POI buildings highlighted and labelled.
- Road network data (for example TeleAtlas), which includes connections between roads (e.g. at junctions), absence of connections between roads that cross but do not connect (e.g. flyovers), classification of roads (Motorway, A, B etc), some pedestrian paths/walkways, and identification of separate road geometries that make up the same complex road layout (e.g. junctions, roundabouts, dual carriageways). Similar data is also available from NavTech and Ordnance Survey.
- POI data (for example E-street and Ordnance Survey AddressPoint), that consists of points with attributes and classifications identifying the nature and specific details of potentially interesting things in the real world (shops, restaurants, landmarks etc). The AddressPoint data has a point for every address in the country, but includes only 'vanilla' information like name (in some cases, particularly businesses), number and postcode. The E-street data identifies a smaller number of points, but with much better classification and information about what and who they represent. POI data is used in the POI selection step.

There are other suppliers of data that may be used by the system.

1.1.5 Software Structure

The location/guidance server 1, in combination with database 2, provides a locating, routing and guidance 'web service' accessible through Internet-like protocols to the LBS running on server 10. The web service provides an Application Program Interface (API) to LBS developers.

The structure of the software that provides this web service will now be described in more detail with reference to Figure 2. The location/guidance technology includes a number of layers, including:

- Web service interface 40 provides the API and infrastructure to allow the LBS to access the location/guidance technology and to allow the location/guidance technology to manage multiple users for the LBS.
- The service modules 42 are software modules which provide various aspects of the location/guidance services, including identifying locations and generating schematics.
- The feature model 44 is a data model which supports the service modules.
- The feature store 46 is a mechanism for overall management of data, providing a single common interface to all data regardless of the source from which it is drawn.
- The connectors 48 are interface modules which allow data stored on disk in different formats to be accessed efficiently and presented to the higher parts of the system through a common interface at the feature store level.
- Data sources 50 are files and/or databases on disk, either in third party formats where databases have been supplied by third parties, or in proprietary formats.

For example, referring back to Figure 1, following interaction between LBS server 10 and mobile device 4, LBS server 10 makes a routing request to guidance server 1. Referring now to Figure 2, this request is received by web service interface 40, which invokes the appropriate one (or possibly several) of service modules 42. The invoked module then requests any required data from feature store 46 using feature model 44. Feature store 46 identifies the source(s) of the required data, and fetches the data from one or more of data sources 50 using the appropriate connector(s) 48.

1.1.6 Indexing Method

A method of indexing geographical features will now be described. The method is used by the system to find features in a given area.

The indexing method splits a large map (for instance a map of the UK) into a grid of patches or tiles. This grid is not necessarily uniform as different tiles may be of different sizes. Each tile includes a list of features located in the geographical area represented by the tile, including roads or POIs such as transport nexuses or shops. Generally, large tiles are used to represent geographical areas with a low density of features, while areas containing a high density of features (for example, urban areas) are represented by small tiles. Since the tiles are of different sizes, it is not possible to directly locate the correct tile solely using known coordinates. Therefore, several layers of tiles at successively lower resolutions are provided, such that in the highest layer a single tile covers a large area and lists all the tiles in the next layer which are enclosed within the area of the higher layer tile.

The indexing algorithm identifies the correct tile by searching downwards through the hierarchy of tiles. In this way, the algorithm searches until it locates the final (highest resolution) tile, which covers an actual geographical area, and lists the features within that area.

The advantage of this indexing scheme is that it is easy to quickly access all the information relating to a specific geographical area. If a single tile does not cover the area of interest, several surrounding tiles are examined. In some embodiments, separate servers each cache information covering a certain area.

1.2 Service Overview

Generally speaking, the location/guidance server 1 provides the following services which are implemented by service modules 42:

- Identifying a mobile device user's present location
- Identifying a user's desired destination
- Generating routing information for routing the user from his present location to his desired destination.

Individual Location Based Services may use only aspects of the services provided. For example, LBS server 10 may request routing information only, providing starting and finishing locations as parameters of the request.

Alternatively, these services may be combined to provide a complete location and guidance service incorporating the three steps of identifying the device's present location, identifying a desired location and providing routing information between the two.

1.3 Example Routing Service

An example of a location and guidance service will now be described in overview with reference to Figure 3.

Routing and location-related queries are received from mobile device 4 via communication network 3 by routing application 100, which manages the

interaction with the user of the routing service. A user interface is provided as part of the routing application, for example in the form of a Wireless Application Protocol (WAP) site. The user interface allows the user to perform tasks such as entering information relating to route start and end points and requesting routing information.

Start/end point module 110 provides services to the routing application, including determining and/or selecting start and end points for a routing request and for determining the location of a mobile device. It uses network fix module 112 to obtain location information relating to the location of mobile device 4 from communications network 3 if required.

Routing application 100 generates routing requests based on the user queries and passes these to routing subsystem 200. These may, for example, comprise two or more geographical coordinates defining a route for which routing information is to be generated.

Routing subsystem 200 comprises router 210, POI selector 220, route segmenter 230 and schematic generator 240.

Router 210 identifies a route based on the received routing request. POI selector 220 selects relevant points of interest along the route to assist the user in following the route. Route segmenter 230 segments the route into separately displayable route sections. Schematic generator 240 generates route schematics of route segments, and may generate other types of schematics, such as route overview schematics, location schematics and orientation schematics.

Start/end point module 110 and routing subsystem 200 communicate with geographical database 2 to access geographical information.

A user profile manager 120 maintains information relating to registered users of the system, which is held in a user profile database (not shown). In some embodiments, some or all of the user-related information is instead or additionally held locally on the mobile device.

User profiles may comprise a variety of types of user information, including:

- Identifying information (for example a user's mobile telephone number and mobile device type)
- Usage histories (for example, recently / frequently visited places)
- Preferences (for example, preferred start / end points, preferred POI types, software configuration preferences). In particular, a list of favourite, commonly used locations is held in the user profile. This is referred to as a "MyPlaces" list.

Users may communicate with the user profile manager using their mobile device 4 (for example, via a WAP site) or via some other device such as a computer terminal 5 connected to the communication network 3 (for example, via a World Wide Web site), and may update their user profiles according to their requirements.

Routing application 100 and routing subsystem 200 customise the routing service and the routing information generated based on information stored in user profiles, which they access via the user profile manager. Furthermore, routing application 100 may update user profiles via the user profile manager in response to user interaction. As an example, routing application 100 may allow a user to add locations to a list of preferred locations held in his user profile, and may automatically record history information relating to a user's routing queries in the user profile.

2. Detailed Description of the Routing Service

The flowchart shown in Figure 4 illustrates an exemplary sequence of steps that may be performed by the location and guidance service. Firstly, the system determines whether the user's current location is known in step 300. If the user's present location has already been determined, the system proceeds to step 302, in which the user's present location is set as the start point for the routing system. If the user's present location is unknown, the system proceeds to step 304 in which the user chooses whether to determine their location automatically using a network fix, or manually using a variety of user-driven methods 308. If the network fix succeeds in locating the user, the system proceeds to step 302; otherwise, the system will determine the user's present location via user-driven methods 308. When the user's position has been determined by user-driven methods 308, the system proceeds to step 302.

After step 302 has been performed, the system determines whether the destination location is known in step 310. If the destination location has already been determined, the system proceeds to step 318, in which the destination location is set as the end point for the routing process. If the destination location is unknown, in step 312 the user chooses whether to use automatic methods 316, user-driven methods 314, or a combination of both to determine the destination location. After the destination location has been determined, either by automatic 316 or manual 314 methods, the system proceeds to step 318.

Once step 318 has been performed, the system determines a route between the appropriate start and end points in step 320 and displays one or more schematic diagrams of the route in step 322, to guide the user between the present location and the destination. If the user becomes lost whilst following the route, the system returns to step 300, where the user's present location may be determined again; otherwise, the system continues to display schematic diagrams 322.

Alternatively, the location of a lost user may be determined using algorithms that do not require the system to return to step 300.

In other examples, the sequence of steps performed by the system may be different to that which is illustrated in Figure 4. For example, the system may not determine the user's current location as the first step of the routing process.

The operation of the location and guidance service will now be described in detail.

2.1 Start/End Point Module

With reference to Figure 3, the start/end point module 110 is responsible for determining the start and end points of the route, which are provided via the routing application 100 to the routing subsystem 200. The start/end point module 110 also interacts with the network fix module 112 to allow the start point of the route to be determined automatically, without requiring user input.

2.1.1 Determination of Current Location

Several automatic and manual methods of performing a location fix on the device 4, as well as combinations thereof, may be provided as described below in sections 2.1.1.1 to 2.1.1.3.

<u>2.1.1.1 Network Fix Module</u>

Automatic and combined methods depend on the ability of the device 4 or the communication network 3 to identify the device's location to within a certain level of accuracy. This is referred to as a network location fix and may be of low, medium or high accuracy. The network location fix may be performed continuously, at regular intervals, or on request. In the schematic diagram of

Figure 3, the hardware and software required to perform a network location fix is represented by the network fix module 112.

Instead of using network 3 to perform the network fix, some other network (not shown) may be used.

Various different types of network fix will be described below, and categorised as 'high', 'medium' or 'low' accuracy,

In an example of a high accuracy system the device 4 incorporates a Global Positioning System (GPS) unit which can fix the location of the unit to an accuracy of 5-10 metres.

In an example of a medium accuracy system the device 4 incorporates an Enhanced Observed Time Difference (EOTD) system designed to implement the FCC E-911 provisions, and can fix location to an accuracy of 50-300 metres.

In an example of a low accuracy system the communication network 3 comprises a cellular network which can fix the location of the device 4 to within an accuracy of up to approximately 250 metres in urban areas (the accuracy may fall to as low as 5-10 km in rural areas) based on the current cell in which the device 4 is registered.

<u>2.1.1.2 Manual Location Fix</u>

Where no network fix is available, or only a low accuracy fix is available, a manual location fix is used. In the schematic diagram of Figure 3, software required to perform a manual location fix is part of the functionality of the start/end point module 110. Generally speaking, the manual location fix is

obtained through a dialogue with the user, in which the user is prompted to supply information relating to his present location.

The purpose of this mechanism is to allow a user to specify a location, whether it is a road name, a road junction, the name of a business or of any other named location or organisation for which geographically referenced data is available.

A first example of a manual fix method is described below in section 2.1.1.2.1 and illustrated in Figure 5. Alternative manual fix methods are described below in sections 2.1.1.2.2 to 2.1.1.2.5.

2.1.1.2.1 Pick List with "X" Letter Algorithm

Referring to Figure 5, in a first step the server 1 determines whether a high or medium accuracy location fix is available. If so, a network location fix is first used to identify the device's location within a certain accuracy.

In the second step of Figure 5, a pick list of categories is displayed. For example, the user may be given the option to search by shop name or road name and house number. In other examples, the first three menu options may be replaced by a single "Business name" option. Selecting one of these options takes the user to a search screen.

The search screen asks the user to enter at least the first "X" letters of the name of a road, business or the like (depending on the selected search option). It may also request further information, such as the house number. In this example, three letters are requested. Generally, the value "X" is calculated dynamically by the following method.

In a first step, an approximate bounding area is determined to reduce the number of features that need to be considered. All subsequent searching only

deals with features within this bounding area. In a preferred embodiment, the bounding area is given by a low accuracy network location fix, for instance the area of the cell in which the device 4 is currently registered. If no network location fix is available, then the bounding area is determined by requesting the user to input a specified area, for instance a town or part of a city. This would occur before the search screen is displayed.

In a second step, the algorithm determines the value "X": a minimum number of characters required such that a "reasonable number" of matches will be found. The "reasonable number" is determined in accordance with the size and resolution of the screen of the device 4, and is selected such that a list of possible matches can be presented on (at most) one or two screens of text on the device 4. "X" is calculated as follows:

- Starting with prefix size 1, for each possible prefix of that size occurring in the relevant data within the bounding area, the number of occurrences of that prefix in the data is calculated. The relevant data comprises those features to which the search relates depending on the search option chosen by the user, for example the names of shops or roads. The prefix with the highest number of occurrences is then determined.

- While the highest number of occurrences for a prefix of the given size exceeds the "reasonable number" (as determined in accordance with screen size) the prefix size is increased and the above calculation is repeated.

Since junction searches use multiple road names, "X" is likely to be lower than it would be for a simple road name search. This is because only specific pairs of road names are involved, based on the known junctions in the specified area.

A search screen is then generated requesting that the user enter at least "X" letters and is transmitted to the device. The user enters a string of letters which are transmitted to the server, where the relevant data within the bounding area is searched for matches. The matches are presented to the user for further selection. Multiple selection screens are provided if the number of matches exceeds the number that can be displayed on a single screen. In one example, the user is presented with a single list split over several pages with a "next page" option. In another example, the list is broken into a hierarchy of related sub-lists. This may occur where the matches cannot be conveniently displayed on a few screens, for example, if the user enters fewer than the requested X letters. It allows the user to quickly "drill down" to the desired entry rather than page through to the entry.

As an example, the list may be broken down into a hierarchy of alphabetically ordered sub-groups. For example, a first series of items is presented:

1. All Bar One - Devonshire Arms
2. Duke of Argyll - Fox and Hounds

Etc.

If the user selects group 1, then they are presented with a list of sub-groups such as:

1.1 All Bar One - Bombadier
1.2 Cambridge Blue - Clarendon Arms
Etc.

The user then selects one of the sub-groups until all of the items in the sub-group can fit on the screen. The menu hierarchy (depth and options displayed) is thus determined on the basis of the device's screen size - smaller devices get deeper sets of menus.

The algorithm then displays an orientation schematic from which the user can pick their current location, as described in more detail in section 2.1.1.3. If the end point is known, one or more junction schematics are then displayed to indicate the route to the user.

2.1.1.2.2 Name Searching Method

In an alternative manual fix method, the user enters an alphanumeric string corresponding, in whole or in part, to the name of the desired start or end points. This method comprises the following four steps:

Step 1: User Input

The system takes an input string (including alphanumeric characters) from the user, for example via a WAP page displayed on a mobile telephone. The string allows the user to specify something about their current location, where they want their journey to start (e.g. if they know they are travelling to a particular location like a train station or car park), or where they want their journey to end. The user may be prompted to enter only the first few letters of the name of the place.

In the case of a road junction, two strings may be specified (e.g. 'Rege' and 'Oxfo' for the junction of 'Regent Street' and 'Oxford Street' in London).

Step 2: Geometric Area Constraint

The system takes a geometric area constraint, derived either from a mobile location feed from a mobile phone network, or from a gazetteer (described in more detail below, under the heading "Details and Refinements").

Step 3: Database Query

The system issues a query, or series of queries, to a database capable of answering queries with both geometry and string components. Examples of such databases include Relational Database Management System (RDBMS) databases (e.g. Oracle 9i Spatial, Postgres) or specialist geographic information systems.

The geometry may be extended. In the case of setting a target for a route, this allows for a reasonable travelling distance (e.g. specified according to a user specified limit about how far they will walk, say 2km). In the case of both start and end points, this allows for inaccuracy in the mobile location mechanism, or for confusion on the part of the user about the entry that they selected from the gazetteer (e.g. saying they are in Westminster when they are actually in the City of London).

The queries may be constructed or executed in a way that allows for more than just a straightforward exact matching between the string values and values in the databases. These 'fuzzy' matches are important because the number of characters that a user can conveniently and accurately type on a mobile phone is significantly less than on a normal keyboard. For example:

- The input string may be matched against the start of the input string in the database.
- If multi-word entries are found in the database, then the string may be matched against the start of each word.
- The query may use a 'soundex' operator, rather than an equality or straightforward pattern matching operator. The 'soundex' operator searches for words that sound like, or whose letter pattern is similar to, the input string..
- The input string may be truncated to its first few (e.g. 4) characters before the match, to reduce the risk of misspelling in longer words.

- Both the input string and the strings in the database may have been abbreviated according to a set of patterns (for example to convert 'Saint' into 'St') representing standard or normal ways of abbreviating words in the relevant language, either on the fly as the query is executed, or as part of the data loading process.
- Substituting characters in the query string for characters typically found on the same key on a mobile phone keypad to allow for common mistypings (for example 'a', 'b', 'c', and '2' are all entered by pushing the same key on a phone a different number of times).

Step 4: Match User Input to Database Query

A set of results representing potential matches to the input criteria is returned by the database. These are then presented to the user, allowing the user to select one that most accurately represents their current location or intended location.

A number or techniques can be used to simplify the presentation of a larger number of results than would conveniently fit on the screen of a small device such as a mobile phone. One technique is to output a series of progressively narrowing output result sets, and receiving a series of selections, each selection being responsive to a respective output result set. Results can typically have a name (e.g. Starbucks), a category (e.g. 'Eating and Drinking'), a street (e.g. Oxford Street), and a number (e.g. '25'). For example, given input 'Star':

- If there are matches with several different categories, present the category first, and allow the user to select the category.
- Then, if there are matches in the same category with different names, present the user with a list of alphabetical ranges (e.g. 'Star of India TO Starbucks').

- Then, if there are matches with the same name in different streets, present the user with a list of the streets (e.g. 'Oxford St' and 'Regent St').
- Then, if there are matches with the same name in the same street, present the user with a list of addresses (e.g. '25 Oxford St', '125 Oxford St').
- By selecting each in turn, the user will have narrowed a large number of possible matches to a single location.

Details and Refinements

In the above description, the geographic extent for searching can be derived from a mobile location feed (e.g. as specified in the Location Interoperability Forum (LIF) standards) or from some previous user input and queries on a 'gazetteer' held in a database.

A gazetteer is a list of place names and locations (specified as points, lines or areas). For example 'London', 'Birmingham' and 'Stonehenge' could all be places in a UK gazetteer. The user selects an entry from the gazetteer by entering a string matching the place name, and a database is searched for matches to that name (using the various 'fuzzy' querying techniques previously described in step 3). When presented to the user, the place names are ordered according to a scoring system intended to present the more likely matches earlier. The scoring system uses:

- The accuracy of the textual match on all the characters entered by the user – an exact match has a higher score than a partial match, a match on the first word has a higher score than a match on subsequent words.
- The size of the area matched – score is proportional to size, with larger areas scoring higher.

A refinement determines scores using statistical data, which may be based either upon the population inhabiting each area, or upon the number of requests observed for each area over a period of time.

Another refinement is to combine the use of a mobile location feed and gazetteer. The gazetteer is searched to determine areas overlapping the area returned by the location feed. The area(s) from the gazetteer are then used as the basis for searching. This means, for example, that a user located at one point in a town can be offered end points anywhere else in the town, not just in the immediate vicinity of their current location.

2.1.1.2.3 Start Point by Nearest Transport Nexus

This alternative start point fixing method enables a start point to be set where an end point is already known.

An end point can be selected in any of the ways discussed below in section 2.1.2. For example, the end point may be a business address where a meeting is being held. The user would then like to determine a suitable place to start from, so that they can arrange travel to that location and then complete the final step on foot. This method aims to minimise the time that the user spends walking by providing information regarding the nearest 'transport nexus' to the end point. The nearest transport nexus could, for example, be a railway station, underground railway station, bus station or other mass transit station, or a car park.

An algorithm to determine the nearest transport nexus considers all possible routes along the road network, working outwards from the desired end point, and searches for possible transport nexuses along these routes. This algorithm ceases searching when the length of a route exceeds a pre-determined maximum distance that the user is prepared to walk, when a certain number of candidate

transport nexuses and routes have been found, or when some condition based on a combination of the two previous criteria is satisfied. Another algorithm considers all transport nexuses within a maximum radius of the desired end point, then finds the nearest road to the transport nexus and finally determines the actual distance by using network analysis to find the path from the start point to the candidate nexus. The choice of transport nexuses that is recommended to the user is based on the results of either or both of these algorithms.

Finding these possible nexuses can be achieved by a database query since the different points of interest in the database, for example bus stops, train stations, underground railway stations and car parks, are classified according to their function. Furthermore, the geographic information database allows queries such as finding all points of interest of a particular classification within a particular bounding box. The road with which a transport nexus is associated can be determined by finding the address of the nexus and then determining if the closest point on the road having the same name is within a certain distance tolerance. If the closest point on the road is not within this distance tolerance, then another road with a shorter distance may be selected.

These possible choices can then be offered to the user, possibly broken down according to their classification, such as bus, train, underground railway, or car park as appropriate. In a particular embodiment the user is provided with an ordered list of possible transport nexuses, which are ranked according to their distance from the destination location. The user is provided with the names of the transport nexuses and the distance from the destination, allowing the user to make an informed choice from the available options.

If identifying, for instance, an underground railway station or a bus stop as the nearest transport nexus, the relevant underground railway line or bus numbers could also be identified.

The selection of transport nexus may also be influenced by the current location of the user. For instance the system may determine the current location of the user by one of the 'network fix' methods described above in section 2.1.1.1 (for instance, a GPS fix). The system then selects a transport nexus which is near to the desired end point, and which is also well connected with the current location of the user.

2.1.1.2.4 Location Codes

In an alternative manual fix method, the location may be specified by a 'code'. The code contains sufficient information to uniquely identify the location and may be displayed at the location, possibly in the form of an advertisement. The user enters the code into a mobile device, which transmits the code to a central server. The code is queried against a database, which returns the coordinates of the location that is represented by the code. These coordinates are then set as the start point of the route.

Alternatively, the code may identify both the start and end points, and thus define an entire route.

2.1.1.2.5 Communication of Location to a Mobile Device

In an alternative method, information identifying a location may be electronically communicated directly to the mobile device 4 from a kiosk or terminal in a known place (for example in a tourist office, hotel or airport). The information may be communicated to the device by SMS, email or by an infrared link. Upon receipt of this information, software on the mobile device sends the location to the routing service and configures the start point of the route accordingly. In other examples of this method, information may be transmitted to the mobile device from any other device that is aware of its

location, such as a similar mobile device that has performed a manual or network location fix, an in-car satellite navigation system or by a global positioning system.

2.1.1.3 Orientation

If more detail is required by a network location fix, or if only a medium accuracy network fix is available, an 'orientation' step is performed. The 'orientation step' is also used where a manual location fix has been made. Another purpose of the orientation step is to confirm that the previously described location fix methods have determined the user's present location correctly.

In the 'orientation' step, the user is displayed with information showing Points Of Interest in the area of uncertainty (as determined by the previous network fix or manual location fix), such as road/footpath junctions, landmarks, key buildings or other points of interest.

In a small device, the user may simply be presented with a textual list of possible locations. The user can then pick one, and get a more detailed graphic orientation schematic showing only that location. The orientation schematic shows the selected location, along with buildings, street furniture or other points of interest. The user is then asked to confirm that he is at that location.

In a medium device, an orientation schematic is displayed first, showing the area of uncertainty, and a number of distinguishable locations.

The orientation schematic covers the entire area of the location-fix. It presents a stylised image based on network data (roads and paths) and POIs.

For instance, the orientation schematic could represent multiple exits from a large building or other structure/area (e.g. office block, tube station, car park). In the case of exits that do not lie at actual road junctions, then a 'virtual junction' is created at the exit. A virtual junction is any point that is not considered to be a road junction by the underlying network data, but is treated as a junction by the routing application for the purposes of determining a route or guiding the user.

The algorithm to generate an orientation schematic considers all network elements, as defined by the underlying geographical data, within the area of the location fix and analyses network connectivity to produce a list of junctions, which is then used to produce a graphical representation of the area. In order to provide pertinent information to the user within the restrictions imposed by the limitations of mobile device display technology, the orientation schematic presents a simplified view of the user's location. Such simplifications include the removal of less relevant information and straightening curved roads within certain tolerances, although the angular interrelationship between roads at junctions is generally preserved.

From an initial orientation schematic, the person selects a junction (or virtual junction) at which they believe they are positioned. The algorithm then presents a 'junction view' routing schematic. The person may then use this to orient themselves, or, if they have chosen the wrong starting point, they may return to the initial orientation schematic to choose a different junction.

More sophisticated devices may allow greater flexibility: for instance a point/click device may be used to allow any location within a displayed area to be selected, instead of limiting the selection to one of the displayed distinguishable locations.

If the user has already input their destination (see section 2.1.2) then the orientation schematic may include an arrow indicating the required direction of movement towards the destination.

If a high accuracy location fix is available, then in some circumstances the network fix may provide sufficient detail to identify the location. In this case, a 'junction view' routing schematic is displayed which provides the user with a graphical representation of their present location. If the user has already specified their destination (as described in more detail in section 2.1.2) then the 'junction view' routing schematic indicates the direction in which the person is to start moving. The person may then use the 'junction view' routing schematic to orient themselves.

<u>2.1.1.3.1 "Can You See?" Search</u>

The principles of the orientation step can be used to perform a type of location fix called the 'Can you see?' search. In this method, the start/end point module determines the location of the mobile device using the network fix module, and then searches for significant POIs in the vicinity of the mobile device. Whether a POI is included in the results of this search is determined by criteria which are intended to indicate its likely visibility to a user on the street. These criteria include size and classification. For example, a church with a spire is probably more visible than an office block, so will preferentially be chosen as a POI. A list of such likely landmarks is returned to the user, who selects a visible landmark from the list, allowing the user's current location to be determined.

2.1.2 Determination of Destination Location

A variety of methods are provided in the start/end point module 110 to enable the user to specify the desired end point of the route.

2.1.2.1 Received Message

One method by which the end point of the routing application may be configured is for a message containing the coordinates of the desired destination to be received by the user's mobile device. In such a message, the name of the location would be specified and also tagged with additional information, specifically the coordinates of the location. The coordinates can be expressed as Lat/Long coordinates (Latitude & Longitude) in a specified coordinate system, such as WGS84, which is the form of output from most GPS devices. Tagging a name with a geographic reference (or location tag) is similar to associating a hypertext Uniform Resource Locator (URL) with a piece of text in an HTML page, and is easily achieved in a markup language.

In an example of this method, the user receives a message to meet their friends at a particular location. In this message, the name of the location (for example 'The Red Lion') is tagged with coordinates that specify the geographical location of this destination. When the user accesses the tag, a messaging client on the mobile device configures the routing application such that the coordinates associated with the location are set as the destination of the route.

2.1.2.2 User Input

Alternatively the location could be input by the user, for instance in a similar manner to the manual location fix described above.

In general, a network fix will not be available to provide a starting point for the destination manual location fix. However, in the case of a cellular communication system, the bounding area for the X-letter search algorithm may be restricted to features in the current cell and surrounding cells. In other examples the bounding area is based on the (already determined) starting location plus a reasonable walking distance; or on a broad area input by the

user, for example a town or part of a city. Alternatively, the bounding area may be specified as the current location of another mobile device. In the latter example, if a medium or high accuracy location fix is available for the second mobile device, this may be used to fix the destination completely.

Once a bounding area has been defined, the identification of the exact destination follows the same procedure as already described for obtaining a manual location fix.

2.1.2.3 Automatic End Point Offer

When a user specifies a start point, the system may automatically offer an end point. For example, the choice of possible locations that is automatically offered as end points may be determined by: the user registering a prior interest in certain services or locations, such as a favourite burger chain or coffee shop; promotions or advertisements from the service provider; a record of the user's recent locations; or a "MyPlaces" feature, as described below in section 2.1.3.2, in which the user can set up a list of locations of interest. In some embodiments, POIs may also be chosen according to the aforementioned criteria.

The automatic end point offer is achieved by carrying out network analysis from the start point in a similar way as described above for finding a transport nexus (see section 2.1.1.2.3 above), instead looking for businesses or points of interest that fall within a certain category. This feature can also be extended to cover advertising. For example, the service may suggest the premises of an advertiser as a possible end point, if such a location exists within a certain distance of the user's current location. Also, on route schematics, these could be preferred POIs.

2.1.3 Alternative Methods for Setting Start and/or End Points

Sections 2.1.1 and 2.1.2 above describe various methods by which the start/end point module can set start and end points respectively. The following sections give further alternative methods for setting start and/or end points.

2.1.3.1 Setting Start and/or End Points by Messaging

The routing application, in particular the start and end points of a route, may be pre-configured using some remote access method. The use of a remote access method allows the user to configure a route without directly accessing the routing application by the use of a messaging system. Suitable messaging systems include Short Message Service (SMS), Multimedia Messaging Service (MMS), email, WAP push or a voice call to an automated speech recognition service.

Configuration of the routing application is initiated when the user sends a message to the routing service, using a messaging system such as one of those previously mentioned. This message is in one of several predefined formats accepted by the routing service and contains information relating to the start and/or end points of the route. Furthermore, the message also contains information that uniquely identifies the user to the routing service, the form of which is dependent upon the messaging service. For example, the telephone number from which an SMS message originates may be used to identify the user of the mobile device. The routing service attempts to identify the user by comparing this information to a database of registered users. If the user is not identified from this information then the user is treated as a new user and is appropriately registered with the service.

The routing service uses the start and/or end point information contained within the message as the basis for a query to a suitable database, which returns

geographical coordinates corresponding to the requested points. These coordinates are then stored in the user's profile. At this stage, the routing service may optionally perform preliminary checks on the coordinates, such as confirming that the distance between the start and end points is less than a predefined limit set by the user. However, the route between the points is not determined at this stage.

The routing service then generates a URL that contains sufficient information to allow the user to be logged into the service and specifies the location of a customised front page for the routing service. The customised front page could be either the main menu of the service in which the route is already configured or could alternatively display the first segment of the route or an overview schematic of the entire route. The URL is then sent to the user via one of the aforementioned messaging systems. By accessing this URL, the user is provided with the routing information that was requested in the original message. If both the start and end points of the route were specified in the message, the route between these points will be determined by the server when the user accesses the URL.

The user may specify the start and/or end points in one of several different formats, including:

- A code number that represents a location. The code 'number' may contain alphanumeric characters. For example, a certain code number may represent starting at a train station.
- Postcodes of the start and end points. Alternatively, the user may supply solely the postcode of the destination address.
- A keyword. For example, if the user's message contains the keyword "bar", the routing service determines the nearest bars to the user's approximate current location and provides the appropriate routing information.

- A reference to an item in a previously defined list of locations. The reference may take the form of a keyword or a code number, and the list of locations may be compiled by either the user or a third party. A user-defined list of locations could be stored in a MyPlaces list (see sections 2.1.3.2 and 2.4). For example, the keyword "home" may be used to identify the user's home address, assuming that user had previously configured the system with the location of their home.
- A start point provided in any of the previously mentioned forms. In response, the routing service automatically sets an end point according to a predefined user preference or service provider preference. In an exemplary embodiment using SMS, the user could select the desired response of the routing service by sending the message to an appropriate number. A higher level service, such as a search engine, could assist the user in selecting a service to which to send the SMS message, by suggesting possible SMS services in response to a user query.

Of course, any of these methods for specifying a location via a message can be combined with any other features of the routing service described herein, such as the ability to set the starting point as a transport nexus (see section 2.1.1.2.3).

In all of these methods, the information provided in the original request may not be sufficient to precisely identify the start and/or end point. For example, a postcode may also require a building number to be specified. However, on connecting to the service via the provided URL, the user is guided through a series of simple additional questions or selections to precisely identify the desired location. Alternatively, the system may take the mid-point of all the possible addresses with that postcode, since a postcode covers a number of addresses within a known geographical area.

An example in which the route is configured by the use of SMS is now described. Firstly, the user sends an SMS message via the mobile phone

network, which is received at an SMS centre. The message is then forwarded through an SMS gateway to a central server, such as the LBS server 10 shown in Figure 1. The central server attempts to identify the user by comparing the number of the mobile telephone from which the SMS message originated to a database. If the mobile telephone number is not recognised, the user is treated as a new user and is registered with the service. Once the user is identified (or registered in the case of a new user), the service configures itself to provide the required routing information and sends a URL to the mobile device by a messaging system such as SMS or WAP push. When the user accesses this URL, the user is logged into the service and provided with the information that was requested in their SMS message.

Other aspects of the routing application may also be pre-configured by messaging. The method is similar to that described above, in which a user sends a message to a routing service, which identifies the user, amends or stores data within the user's profile and then responds by returning a URL to the user via a messaging system. The user may see the outcome of the requested action by accessing the URL.

2.1.3.2 Setting Start and/or End Points Using "MyPlaces"

"MyPlaces" is used to store locations that the user anticipates using as start and end points in the future. This concept can also be extended to allow the storage of a complete route. Location tags, or their containers, can be stored as a list of MyPlaces either on the mobile device 4 or on some mobile portal (not shown). Containers for location tags can be generated by a variety of applications (for example a web site generating web pages from information in a directory).

The list of MyPlaces might include fixed points such as the user's office or home, but becomes much more powerful when entries can be created from

location information provided from another source. Examples of such sources include:

- A third party such as a friend or colleague trying to provide information about where to meet – or a receptionist trying to provide 'last mile' directions over the phone to a visitor finding their way to an office
- A 'how to find us' section of a web site where the user wants to have the information available from his phone – rather than having to print a map
- A user preplanning a route using a web site specifically associated with the routing & guidance service or a general internet mapping site for the same application
- An extended output from a Directory Enquiries service which includes the location of the listing as well as the telephone number
- The location of a friend or relative who is happy for the subscriber to know where they are for defined periods

The addition of entries to a MyPlaces list involves the execution of a simple script from a website that only requires the entry of the mobile number of the MyPlaces owner for identification. This is sufficient to ensure that the location is added to the personal MyPlaces list for that user – held as a simple database within the wider service, for example by the user profile manager (see section 2.4).

2.1.3.2.1 Enhancement of MyPlaces

The use of MyPlaces can be further enhanced by techniques such as the following:

- External access: the MyPlaces list can be accessed by the user, or by someone else, through a means other than just their mobile device. This method allows places or routes to be managed, added or removed. For

example, a web site or messaging mechanism could be used by the user, or by, say, the receptionist of a company that the user is going to visit. In the case of a message, any of the mechanisms outlined in the previous sections for setting start and end points, and complete routes, could be used.

- Automatic transmission of changes: when a new place or route is added to MyPlaces, a message (WAP push, SMS, or email for example) containing a URL that identifies the newly added place/route can be sent to the mobile device. The information referenced by the URL can then be immediately used by the user of the mobile device.
- Automatic storage and removal of MyPlaces: recently used places are added to MyPlaces, in a similar method to that of a history mechanism in a web browser. An algorithm keeps track of how frequently and how recently these places have been used as start/end points for routes. The less frequently, less recently used places are removed from the list, such that the list remains below a predetermined maximum capacity.
- Guided tour: A list of places that one may wish to visit, for example, tourist attractions, may be generated together with a route that passes through each of these locations. For example, rather than generating a route from A to B as was described in previous examples, a circular route from A to A via B, C and D may be generated.

As described above, third parties may communicate with the central server to update the personalised list of locations associated with a specified user. Each of these updates returns an update identifier to the third party which can be communicated asynchronously to the user. Upon receipt of communications containing the update identifiers, the user may select one and initiate an interactive communication with the central server by passing the update identifier from the selected communication. Alternatively the user may already be in interactive communication with the central server, in which case the central server will prompt the user and allow them to select an update from a

menu of options identifying the updates. Alternatively the user may not specify an update identifier when starting an interactive communication with the central server, in which case the central server will allow the user to select an update from a menu of options identifying the updates. If an update is specified then the central server applies the updates and returns a revised set of options to the user.

In addition to specifying one or more locations of interest, updates from a third party may indicate that specific locations should be used as a route start point, a route end point, part of a list of possible route start points, or part of a list of possible route end points.

If the user selects an update that identifies route start points or end points as described above, the central server may present options to the user that optimise the process of defining a new route. For example, if both the route start point and route end point have been specified, the central server may immediately display information such as the length of the route and the estimated time taken to walk along the route.

Communication between the third party and the central server may use techniques that differ from that used for interactive communication between the user and central server. For example it may use a messaging-based approach using SMS or email, or an interactive approach such as through a web site or mobile portal. Examples of a third party specifying route start points and/or end points include:

- a receptionist providing the location of an office to be setup as the route end point and a list of nearby train stations as possible route start points
- the 'how to find us' section of a web site allowing a location to be setup as a route end point
- a user pre-planning a route

- a second user sending a 'meet me here' message containing their current location or, if they are a user of the service, sending a 'meet me here' message with an identifier allowing the central server to ascertain their current location.

Communication between the third party and the user may use techniques that differ from that used for interactive communication between the user and central server. For example it may use a messaging based approach such as WAP push to notify the user.

The user may communicate with the central server as a third party. The user might identify route start and end points by including additional information in the communication, specifying these points by any appropriate method such as those described elsewhere in sections 2.1.1 to 2.1.3.

An example of the use of MyPlaces is shown in Figure 6.

In this example, a MyPlaces user is travelling to an appointment at a city centre office he is unfamiliar with. He parks his car at a public car park and then realises he does not know exactly how to get to his chosen destination.

1. The user dials the office he is trying to reach and asks the receptionist to go to the MyPlaces web site.
2. The receptionist enters his mobile number into a form and then the address of the office.
3. The user accesses the MyPlaces service on his mobile, which now has the new MyPlaces location that has just been created set as the current target, and receives dynamically created step by step directions to the office.

2.1.3.3 Reverse route

The start and end points of a route may be transposed to provide guidance on following a previously defined route in the opposite direction. This functionality allows the start and end points of return journeys to be selected, with a minimum of user interaction.

For example, a user travels from point A to point B on an outwards journey. Points A and B are selected as the start and end points respectively using any of the methods previously described in sections 2.1.1 to 2.1.3. When the user wishes to return from point B to point A, the user can choose a 'reverse route' option, which automatically sets points B and A to be the start and end point respectively. Thus, the user can quickly obtain directions for the return journey without the need to manually re-enter a current location and destination.

2.2 Routing Application

With reference to Figure 3, once the current location and desired destination of the device have been identified with sufficient accuracy by the start/end point module 110, the routing application 100 is able to direct the user from one to the other. Also, instead of identifying the device's current location, the user may specify a different starting location. The user may, for example, wish to plan a later journey with a starting point different to his current location. This can be achieved using the same procedure as described for the identification of the destination.

In an exemplary embodiment, once a starting and destination location have been specified, the user may select a "Directions" option from the main menu in order to obtain routing information.

The routing information provides information describing the route from the selected starting location to the desired destination and can comprise graphical and textual information. The user is guided along the route by an interactive process, which involves frequent communication between the user and the routing service. Typically, the routing information is arranged in segments (referred to hereinafter as "routing schematics") providing detailed information of the first and subsequent sections of the route. When each segment of the route is displayed, the user can indicate to the routing service that they have reached the end point of the route, that they have followed the routing instruction and require the next schematic or that they are lost.

The user may realise that they are lost if the schematic does not correspond to their current location. Thus, by splitting the route into suitable sections and supplying POIs against which the user can verify their position, the likelihood that the user can stray a long distance from the correct route before realising that they are lost is minimised. The corrective action that may be taken should the user become lost is described in section 2.2.3.

Another advantage of separating a route into a series of individually displayable schematics is that the amount of information that is displayed on any single schematic is reduced, which helps to ensure that each schematic is easily comprehensible by the user. Furthermore, separating the route into small segments facilitates the display of schematics on mobile devices with small screens.

2.2.1 Overview Schematics

Optionally, an overview of the entire route may be presented before the first routing schematic. The overview provides a summary of the requested route. For instance an overview generated for a small screen may contain only text and show distance and walking time. From here the user may proceed to obtain

more detailed routing information. The server then generates and transmits to the mobile device the information for the first segment of the route.

Where a large enough screen is available, the summary also includes a graphical overview of the route.

Exemplary screenshots of overviews for small and large screens are given below in section 3.4 of the "Walk-Through" section.

2.2.2 Routing Schematics

The user is then led through the route via a series of routing schematics. These schematics may be generated on request from the user (for example by selecting a 'next route segment' option, clicking on an appropriate icon or pressing an up/down button), or may be generated in some intelligent way: for example by carrying out regular network fixes to monitor the current location of the user and updating the routing schematic in response to changes in the current location. These regular network fixes may be assisted by the knowledge of where the user has been previously on the route.

A further alternative would be to send a strip of images. For example, the new MMS system (Multimedia Messaging Service) allows a collection of images to be sent to a mobile phone, so that the entire route can be sent as a collection of images. A system may thus be provided in which the user sends an SMS with a postcode to the service and the service returns a series of route pictures or schematics via MMS.

2.2.3 Lost While Following Route

A user who has become lost whilst following the route, perhaps by taking a wrong turning, could use any of the normal start point selection mechanisms to reset their current location and then continue to their end point.

For example, if no network fix is available, or only a low accuracy network fix is available, then a new manual location fix can be carried out. If a medium accuracy fix is available, then this can be used the starting point of an orientation step, as in section 2.1.1.3. If a high accuracy network fix is available, then no orientation step may be necessary.

However, there is considerable scope to make this much simpler using a variety of techniques. The premise for this functionality is that the user's current location is essentially known, as it is highly unlikely they have walked very far before realising that they have mistakenly strayed from the correct route. The system can then intelligently offer some choices of where the user is likely to be.

The following approach is possible:

- Use network analysis to determine both the last few junctions on the route, and those junctions that are close (in network terms) to those junctions. These are then the likely junctions that the user has walked to by mistake. Typically, the network analysis considers the directions in reverse to find the last correct junction that the user passed and then generates a list of any adjacent junctions that the user may have arrived at by taking a wrong turn.
- Offer the user the choice of these junctions as possible current locations. These junctions could be identified by road names, or by significant POIs, i.e. shops, pubs, restaurants etc., at each junction. In the case of POIs, only POIs that uniquely identify a junction will be offered.

- If the user is not at any of these junctions, then the system could take a further step back in the route and look at the previous junction and identify any junctions adjacent to that junction.
- Once the user chooses a junction, the route is reset to start at that junction.
- Optionally, this could be combined with a mobile location feed to further constrain the junctions offered.

2.2.4 Time Dependent Functionality

Services may be provided which vary in accordance with the time of day. For example, the choice of transport nexus (see section 2.1.1.2.3) can be influenced by time-dependent variations in train, bus or underground railways services, or by the opening hours of train, bus or underground railway services. In another example, a route can be chosen to avoid traffic congestion that occurs during peak hours. In a further example, a route that avoids unlit streets can be chosen at night. Time-dependent variations in the choice of start point, end point or route can also be influenced by the user's preferences.

2.2.5 Location Schematics

As an alternative to generating an entire route based upon defined start and end points, location schematics, which indicate a target location in the context of well-known landmarks, may be displayed. For example, if the user is familiar with the area but cannot recollect the exact location of the destination then they can choose to 'display' its location tag. The server 1 accepts the location tag and returns a location schematic. Location schematics provide a convenient alternative to the standard routing process and require less computational effort than the process of determining a route and generating a sequence of schematics.

The location schematic is used to describe where something is to a person who is familiar with the area. In some cases this is merely a matter of 'jogging their memory' (for example 'the Tram Depot' is the pub just off East Rd.). The standard routing process, as described in the preceding sections is, of course, more suitable for users that are unfamiliar with the area.

The purpose of the location schematic is to provide a person with a general idea of where either they, or some other location, are situated by reference to major features or landmarks in the vicinity. The aim is to choose landmarks that the person may be familiar with. It is not necessary that the landmarks actually be visible from the place. However it is necessary that there are sufficient landmarks shown to give an approximate idea of where the destination is. One of the aims is to avoid needing to provide the user with more detailed instructions on how to reach the destination.

The location schematic is generated by searching within a pre-defined radius of the destination for network elements (for example roads and paths) as well as POIs. The method of selecting POIs is described in section 2.3.2.

Routes are generated between the selected POIs and the target location. The cost of traversing network elements is weighted to favour major roads and paths. If any of these routes has a length greater than a threshold value, the POI is removed and an alternative sought. The extents (expressed as Minimum Bounding Rectangles) of the routes, POIs and destination are combined to provide a total extent for the schematic. A simplified graphical view is generated that includes the destination, POIs and some of the network. The network elements used in the routes are selected such that they become more significant (based on the classification inherent in the network data) as they move away from the destination. Thus minor roads connecting a POI to a major road that then leads to the destination are not displayed.

Alternatively, a textual version may be produced that describes the destination as being near the POIs and, optionally, as lying along particular roads.

2.2.6 User Interface

In general, the format of the user interface to the routing application will be dependent upon the type of mobile device. The user interface for small devices will be largely text-based, while medium and large devices may have graphical user interfaces (GUIs).

An exemplary embodiment of the user interface for a small screen device will now be described. The user is required to log in when connecting to the routing service, using a password or Personal Identification Number (PIN) to confirm the user's identity. After successfully logging into the service, the user is presented with a main menu, which forms the top level of a menu hierarchy and includes the following options:

- Set start point
- Set end point
- Reverse route
- Follow route
- Resume route
- Configure MyPlaces
- Configure user profile
- Logout

The 'Set start point' and 'Set end point' options allow users to define their present and destination locations using methods such as those described in section 2.1, while the 'Reverse route' option provides a quick method to set a return journey as described in section 2.1.3.3.

By selecting the 'Follow route' option, the user is presented with one or more schematics to indicate the route. The user may press a button on the mobile device's keypad to move to the next in a sequence of schematics, if appropriate. Whilst viewing the schematic, a variety of functions may be accessed from a menu including: 'In' and 'Out', which respectively increase and decrease the level of magnification at which the schematic is viewed; 'Dist', which provides an indication of the distance covered on the route so far; and 'Main Menu' which allows the user to exit from the schematic view. The user may return to the schematic view at a later point via the 'Resume route' option of the main menu.

The 'Configure MyPlaces' option of the main menu allows users to add and remove entries from their MyPlaces list. The 'Configure user profile' option allows the user to customise other aspects of the routing service, such as the maximum length of routes. Finally, the 'Logout' option allows the user to exit from the routing service.

At appropriate points in the routing software, the user is provided with a 'Tips' option, which can be accessed to display contextual help on aspects of the routing service or user interface.

2.3 Routing Subsystem

The routing subsystem 200 will now be described with reference to Figure 3. The routing subsystem determines the route between the start and end points, which are provided by the start/end point module 110 via the routing application 100, and generates schematics of the route for display on the mobile device 4. The functions of each of the components of the routing subsystem will now be described.

2.3.1 Router

The router 210 selects a route between the geographical coordinates that represent the previously defined start and end points. The route is selected based on criteria including minimisation of distance or journey time, user preference and predefined user profile settings. The router also builds a network of roads that are adjacent to the route but not part of the route itself.

2.3.2 POI Selector

Once the router 210 has determined a route, the POI selector 220 chooses POIs along the route to assist the user. The POI selection algorithm assesses criteria including: distance from the route or other location to be identified; 'sector ranking', in which POIs that are adjacent to the route at road junctions are given preference to those POIs that are not adjacent to the route; 'significance', which can be influenced by the relative abundance of such POIs or user profile settings; the size of the text label that would be required to identify the POI; information included in the user profile, such as "MyPlaces" data; service provider preferences; the visibility of the POI from the route; and the type of schematic to be generated, i.e. whether it is a routing or an orientation schematic.

2.3.3 Route Segmenter

The route segmenter 230 separates a route, which has been previously determined by the router 210, into individually displayable sections. The algorithm to separate the route assesses criteria including: 'junction significance', in which junctions at which the user must turn onto a different road or the junctions of major roads are most likely to be selected as the start and end points of a route section; the complexity of the path between junctions that are considered to be 'significant'; and user interaction with the routing

subsystem. In some embodiments, the geometry of the route is simplified prior to segmentation, to improve the clarity of the schematic.

2.3.4 Schematic Generator

The schematic generator 240 renders a schematic for display on the mobile device 4, based on the outputs of the router 210, POI selector 220 and route segmenter 230. The schematic generator may choose to adjust the location and appearance of POIs, junctions and adjacent roads in order to improve the clarity of the resulting schematic.

The schematic generator also adds labels to the schematic, to assist the user in identifying features along the route. Since the available screen space for labelling roads, POIs and other features is limited, an algorithm selects which features to label, and determines the format and placement of labels. This algorithm considers criteria including possible conflicts between the label and other features of the schematic and the distance of a label from its associated feature.

The schematic generator may incorporate additional information into schematics, such as sun position, moon position, shadows, display of a compass or supplementary labels, where appropriate.

2.4 User Profile Manager

With reference to Figure 3, the user profile manager 120 maintains various information relating to the user. This information is known as a 'user profile' and is stored in a database or on the mobile device 4. In one embodiment, this information includes the user's personal details such as name, home address, telephone number, email address, type of mobile device and credit card number for payment purposes. This user profile can also include demographic

information such as age, sex, occupation, income and interests, to enable sponsor-based services, such as the 'automatic end point offer' described in section 2.1.2.3, to be targeted to appropriate users. Each user's profile can be identified by a unique user identification number.

User profiles also contain information that allows users to customise the location and guidance service to suit their preferences. For example, the user can choose to customise the appearance and functionality of schematics, and can specify the maximum length of any routes that are generated. The user profile also stores a MyPlaces list of the user's favourite locations (see section 2.1.3.2). A list of the user's favourite routes, a list of recently visited locations and a list of recently travelled routes may also be stored in the user profile.

Additionally the user profile contains information required to implement the 'setting start and/or end points by messaging' functionality that was described in section 2.1.3.1. This information includes the data required to identify the user or the user's mobile device, such as an email address or mobile telephone number, and routing information that can be accessed by a URL.

2.5 Customisation

As mentioned above, the route selection and generation of schematics may vary depending on user profile, screen size etc. In addition, this may vary depending on the profile of the LBS. For instance the LBS may be a specialist service providing directions to pubs. In this case, the POI selection parameters are weighted so as to select pubs in preference to other POIs.

2.6 Further Preferred Features

Further preferred features of the invention are described below in Annex A.

3. Walk-Through

A series of exemplary screen shots will now be described with reference to Figures 7 to 20.

The screen shots shown in Figures 7 to 20 are examples of what may be displayed by the mobile device 4 in an exemplary implementation. Other implementations are possible. Specifically, user interaction may be implemented in a different manner from that suggested in the screen shots depending on the type of mobile device used. Furthermore, the user interaction aspects may depend on the nature of the LBS using the location/guidance services, and on the nature of that use.

For instance, the user interface may employ icons which are appropriate for devices with point/click style interfaces. It will be appreciated that hyperlinks or action keys may be used instead, or any other means appropriate to the particular device being used.

3.1 Main Menu

An exemplary main menu is shown in Figure 7. The user is presented with three options:

- Where are you?
- Destination?
- Directions

In the example of Figure 7, the user has already specified his current location as the "Red Bull" pub and his required destination as the "Six Bells" pub.

3.2 Pick-List

An exemplary pick list is shown in Figure 8, including, for example, the option to search by shop name or road name and house number. In other examples, the first three menu options may be replaced by a single "Business name" option. Selecting one of these options takes the user to a search screen such as one of those shown in Figures 9 to 12.

3.3 Location Search

An example of a location search is described below with reference to Figures 9 to 12. In this example, location fixes are performed using the '"X" letter algorithm', which was described in section 2.1.1.2.1.

In Figure 9, the user is asked to enter at least three letters of the name of a bar or pub. If there is an exact match and the three letters entered unambiguously identify a specific bar or pub, that bar or pub will be selected as the user's present location and the user will be returned to the main menu of Figure 7. If not, a pick list of locations will be displayed, as shown in Figure 10.

In this example, the user enters the letters "GRE" on the screen of Figure 9, which produces three possible matches. These are displayed and may be selected on the screen of Figure 10.

In the examples, starting from Figure 8, if the user selects the "Road Junction" search option, then the user is prompted to enter at least three letters each of two roads in the screen of Figure 11. If the user selects the "No. and Road Name" search option in Figure 8, then the user is prompted to enter a house number and at least the first three letters of the road in the screen of Figure 12.

3.4 Overview

Figure 13 gives an example of an overview schematic generated for a small screen, containing only text and showing distance and walking time. From here the user may proceed to obtain more detailed routing information, in this example by clicking on the icon consisting of a circle and an arrow, which causes a route update request to be sent to the server.

Where a large enough screen is available, the overview also includes a graphical representation of the route, as illustrated in Figure 16.

3.5 Small Screen Routing Schematic Examples

Figures 14 and 15 are examples of routing schematics shown on a small screen. Figure 14 is a junction schematic and Figure 15 is a non-junction schematic. The routing schematics include outlines of buildings and roads, and names or numbers of buildings. Arrows show the route the user should take through the junction. Specifically, as can be seen in Figure 14, a first arrow shows the route to be taken into the junction, and a second arrow shows the route to be taken out of the junction.

Text directions for that segment are also shown, along with distance and time remaining. In these examples, interface icons are provided for zooming in and out (-, +), and for moving to the previous or next route schematic (<-, ->), and an up arrow icon is provided for returning to the main menu of Figure 7. As previously stated, the actual user interface depends on the nature of the device.

For example, in Figure 14 the schematic includes a textual description of the route segment (the number in square brackets in this example is the segment number): "Directions: [3] turn left out of 'Fen Causeway' onto 'Trumpington Rd'. 1281m to target - 15 mins"; and a graphical representation of the junction

between Fen Causeway and Trumpington Rd. A feature visible from the junction ("Royal Camb Hotel") is also labelled by way of a box of text superimposed onto the graphic. It should be noted that the box of text does not obscure any important information in the graphic.

3.6 Large Screen Routing Schematic Examples

Figures 17 and 18 are examples of route schematics as shown on a large screen. Unlike the small screen equivalents of Figures 14 and 15, here more than one junction is typically shown per screen. Features include street names, building names/numbers, road stubs at junctions etc. Arrows and dotted lines show the suggested route. Remaining distance and time are also shown. During daylight hours, an icon of the sun could also be displayed, showing the position of the sun in the sky – this helps the user work out which way he is currently facing. A moon icon may be displayed at night.

Referring by way of example to Figure 17, at a first junction, Lensfield Rd is labelled by a text box. At that junction, two roads meet Lensfield Rd from the right, and one road meets Lensfield Rd from the left. These roads are not labelled. A route arrow leads the user through this junction, staying on Lensfield Rd. At a second junction, Lensfield Rd terminates and continues as Gonville Pl. At the junction between Lensfield Rd and Gonville Pl, two other roads (not labelled) join from the left and right. Three features visible from this junction are labelled: namely a Lloyds TSB Bank on the left, and numbers 1 and 2 Gonville Pl on the right. Two other houses in Gonville Pl which are not visible from the junction are illustrated in Figure 17, but not labelled. This keeps the amount of information down to a minimum.

An example of a sun icon is shown in Figure 19, where a sun icon is displayed slightly to the left and below the label reading “Ymca”. This feature could conceivably also be used on a small screen.

A method of indicating the direction of shadows is shown in Figure 20. A depiction of the sun is fixed in a corner of the screen but shaded according to the direction shadows will be thrown. Alternative versions of the software could display shadows thrown by the actual items in the map.

4. Modifications/Combinations

It will be understood that the present invention has been described above purely by way of example, and modifications of detail can be made within the scope of the invention.

Each feature disclosed in the description, and (where appropriate) the claims and drawings may be provided independently or in any appropriate combination.

Reference numerals appearing in the claims are by way of illustration only and shall have no limiting effect on the scope of the claims.

CLAIMS

1. A method of providing route information, the method comprising the steps of:
   a) storing a list of location identifiers;
   b) selecting one of the stored location identifiers;
   c) generating route information associated with the selected location identifier; and
   d) outputting the route information generated in step c).

2. A method according to claim 1 wherein the route information is output to a device, and the method further comprises the steps of:
   a) receiving a selection request from the device; and
   b) selecting the location identifier from the list in accordance with the selection request.

3. A method according to claim 1 or 2, further comprising the step of updating the list of location identifiers.

4. A method according to claim 3, wherein the step of updating the list of location identifiers comprises updating the list in response to a received update request.

5. A method according to claim 4, wherein the update request comprises one of: an SMS message; an MMS message; a WAP push message; an e-mail message; and a voice call to an automated speech recognition service.

6. A method according to claim 4 or 5, wherein the update request is received from a website.

7. A method according to any of claims 3 to 6 further including the step of notifying a user that the list of location identifiers has been updated.

8. A method according to any of claims 3 to 7 wherein the list of location identifiers is updated by adding a new location identifier which has been previously used by a user associated with the list.

9. A method according to any of claims 3 to 8 wherein the list of location identifiers is updated by monitoring the use of each location identifier in the list, and removing less recently used location identifiers from the list.

10. A method according to any of claims 3 to 9 wherein the list of location identifiers is updated by monitoring the use of each location identifier in the list, and removing less frequently used location identifiers from the list.

11. A method according to any of the preceding claims, further comprising the steps of:
a) providing a region schematic comprising data associated with a specified region; and
b) providing at least one routing schematic indicating a route from a first location to a second location.

12. A method of providing route information, the method comprising the steps of:
a) providing a region schematic comprising data associated with a specified region; and
b) providing at least one routing schematic indicating a route from a first location to a second location.

13. A method according to claim 11 or 12 wherein the region schematic is an orientation schematic and the specified region includes the first location.

14. A method according to any of claims 11 to 13 wherein the region schematic is a location schematic and the specified region includes the second location.

15. A method according to any of claims 11 to 14 wherein the region schematic is an overview schematic and the specified region includes both the first and second locations.

16. A method according to any of the preceding claims comprising outputting a plurality of route schematics which together provide an ordered sequence of directions from a first location to a second location.

17. A method of providing route information, the method comprising outputting a plurality of route schematics which together provide an ordered sequence of directions from a first location to a second location.

18. A method according to claim 16 or 17, further comprising receiving a routing request including the first location and the second location.

19. A method according to claim 18 wherein the routing request is received from a user device; and the route schematics are transmitted to said user device.

20. A method according to any of claims 16 to 19 wherein the route schematics are output in sequential order.

21. A method according to any of claims 16 to 20 further comprising receiving one or more route update requests; and wherein at least one of the route

schematics is a route update schematic which is transmitted in response to a respective route update request.

22. A method according to claim 21 wherein each route update request is received from a user device; and each route update schematic is transmitted to said user device.

23. A method according to claim 21 or 22 wherein each route update request is generated in response to a user input.

24. A method according to any of claims 11 to 23 further comprising the steps of:
   a) selecting a sequence of nodes which define a route between the first location and the second location; and
   b) compiling a route schematic for each selected node.

25. A method according to any of the preceding claims further comprising performing a network fix to monitor the current location of a mobile device, wherein the or at least one of the schematics is transmitted in response to a change in the monitored location of the mobile device.

26. A method according to any of claims 11 to 23 wherein at least one of the route schematics comprises a summary schematic giving an overview of directions from the first location to the second location.

27. A method according to any of the preceding claims wherein the route information is output to a hand-held device.

28. A method according to any of claims 11 to 27 wherein the plurality of route schematics are output together as a collection of images.

29. A method according to any of claims 11 to 28, wherein the plurality of route schematics are output using a messaging mechanism adapted to transmit multiple images in a single message.

30. A method according to any of claims 11 to 29 wherein the plurality of route schematics are output together in an MMS message.

31. A method of providing route information, the method comprising receiving input data; receiving area constraint data; querying a data source with the input data and the area constraint data; outputting the results of the query; receiving a selection identifying one of the output query results; generating route information in accordance with the selection; and outputting the route information.

32. A method according to claim 31, wherein generating route information comprises generating at least one route schematic.

33. A method according to claim 31 or 32 wherein the input data comprises a string of characters, and the method further comprises truncating the string of characters, and the data source is queried using the truncated string of characters.

34. A method according to any of claims 31 to 33 wherein the input data comprises a string of characters, and the method further comprises generating at least one additional set of input data by substituting characters in the string with other characters, and querying the data source with the at least one additional set of input data.

35. A method according to any of claims 31 to 34 wherein the input data is received from a keyboard, and wherein the characters are substituted by characters found on the same key of the keyboard.

36. A method according to any of claims 31 to 35 wherein the input data comprises a string of characters, and querying the data source comprises searching for words that sound like, or whose letter pattern is similar to, the string of characters.

37. A method according to any of claims 31 to 36 wherein the one of the output query results is identified by outputting a series of progressively narrowing output result sets, and receiving a series of selections, each selection being responsive to a respective output result set.

38. A method according to any of claims 31 to 37 wherein the area constraint data is received by a manual method.

39. A method according to any of claims 31 to 38 wherein the area constraint data is received by performing a network fix to identify the current network location of a mobile device.

40. A method according to claim 39 wherein the network fix comprises identifying a current cell in which the mobile device is currently registered.

41. A method according to any of claims 31 to 40 wherein the area constraint data is received by performing a network fix to identify the current network location of a mobile device; querying a geographical index with the current network location; outputting the results of the geographical index query; and receiving a selection identifying one of the geographical index query results.

42. A method according to any of claims 31 to 41 wherein the area constraint data is received by querying a geographical index; and the results of the geographical index query are ranked in accordance with one or more criteria.

43. A method according to claim 42 wherein the geographical index is queried with a set of characters, and the criteria include the accuracy of the character match.

44. A method according to claim 42 or 43 wherein the criteria include the size of the results of the geographical index query.

45. A method according to any of claims 42 to 44 wherein the criteria uses statistical data.

46. A method according to claim 45 wherein the statistical data includes the population inhabiting the area covered by the result of the geographical index query.

47. A method according to claim 45 or 46 wherein the statistical data includes the number of requests observed for each result of the geographical index query over a period of time.

48. A method according to any of claims 31 to 47 wherein the data source is queried by means of a keyword search.

49. A method of providing routing information, the method comprising associating a plurality of locations or routes with respective codes; storing the codes in a data source; receiving input data; selecting one of the locations or routes by querying the data source with the input code; generating a graphical schematic of the selected location or route; and outputting the graphical schematic.

50. A method according to claim 49 wherein the codes are advertised in their respective locations.

51. A method according to claim 49 or 50 wherein the input data comprises a message.

52. A method according to any of claims 49 to 51 wherein the input data comprises a message in a format selected from SMS, MMS, WAP push, a voice call to an automated speech recognition service, or e-mail.

53. A method of providing a service, the method comprising receiving a service request from a user device; storing information relating to the service request; outputting a specifier relating to the service request to the user device; and generating a service response to the service request.

54. A method according to claim 53, further comprising receiving an access request from the user device, the access request comprising the specifier, and outputting the service response to the user device in response to the access request.

55. A method according to claim 54, wherein the service response is at least partially generated in response to the access request.

56. A method according to any of claims 53 to 55, wherein the service is a routing service, the service request comprises a routing request, and the service response comprises routing information.

57. A method according to any of claims 53 to 56, wherein the service response is at least partially generated before outputting the specifier.

58. A method according to any of claims 53 to 57 wherein the specifier comprises a Uniform Resource Locator (URL) address.

59. A method according to any of claims 53 to 58 wherein the service request comprises a message in a mobile telephony messaging format.

60. A method according to claim 59, wherein the messaging format is one of SMS, MMS, WAP push, a voice call to an automated speech recognition service, and e-mail.

61. A method according to any of claims 53 to 60 wherein the specifier is output to the user device in a mobile phone telephony messaging format such as SMS, MMS or WAP push.

62. A method of providing route information between a known first location and a second location, the method comprising querying a data source with the known first location to identify the second location near the known first location; generating route information from the known first location to the identified second location; and outputting the route information.

63. A method according to claim 62, wherein the known first location is a known end point and the identified second location is an identified start point, and wherein generating route information comprises generating route information from the identified start point to the known end point.

64. A method of providing route information to a known end point, the method comprising querying a data source with the known end point to identify a start point near the known end point; generating route information from the identified start point to the known end point; and outputting the route information.

65. A method according to claim 63 or 64 wherein the identified start point is a transport nexus such as a railway station, underground station, bus station, bus stop or public car park.

66. A method according to claim 65 further comprising outputting a relevant transport code associated with the transport nexus.

67. A method according to claim 66 wherein the transport code is a railway line or bus number.

68. A method according to any of claims 63 to 67 wherein the start point is identified by performing a network search of the data source outwards from the known end point until either a maximum distance is reached, or until a predetermined maximum number of candidate start points have been reached.

69. A method according to any of claims 63 to 68 wherein the start point is identified by identifying all candidate start points within a predetermined radius of the known end point, and performing a network analysis of the candidate start points to determine the nearest candidate end point.

70. A method according to any of claims 63 to 69 wherein the start point is identified based on the time of day.

71. A method according to any of claims 63 to 70 wherein the start point is identified by locating a feature such as a transport nexus; finding the address of the feature; determining if the closest point on the road having the same name is within a certain distance tolerance; and if the closest point on the road is not within this distance tolerance, then selecting another road with a shorter distance.

72. A method according to any of claims 63 to 71 wherein the start point is determined by outputting a plurality of options to a user, and receiving a user selection.

73. A method according to claim 72 wherein the options are broken down by classification, or distance from the known end point.

74. A method according to any of claims 63 to 73, wherein the known first location is a known start point and the identified second location is an identified end point; and wherein generating route information comprises generating route information from the known start point to the identified end point.

75. A method of providing route information from a known start point, the method comprising querying a data source with the known start point to identify an end point near the known start point; generating route information from the known start point to the identified end point; and outputting the route information.

76. A method according to claim 74 or 75 wherein a user has previously registered an interest in the end point, and wherein the route information is output to said user.

77. A method according to any of claims 74 to 76 wherein the end point is identified by performing a network search of the data source outwards from the known start point until either a maximum distance is reached, or until a predetermined maximum number of candidate end points have been reached.

78. A method according to any of claims 74 to 77 wherein the end point is identified by identifying all candidate end points within a predetermined radius of the known start point, and performing a network analysis of the candidate end points to determine the nearest candidate start point.

79. A method according to any of claims 74 to 78 wherein the end point is identified based on the time of day.

80. A method according to any of claims 74 to 79 wherein the end point is selected from a stored list of location identifiers.

81. A method according to any of claims 74 to 80 wherein the end point is selected in accordance with a stored demographic profile.

82. A method of providing route information, the method comprising receiving a request containing coordinates of a desired destination, generating at least one schematic providing directions from a start location to the desired destination, and outputting the or each schematic.

83. A method according to claim 82 wherein the request includes the name of the desired destination.

84. A method according to claim 82 or 83 wherein the coordinates are expressed as latitude and longitude coordinates.

85. A method of providing route information, the method comprising outputting one or more route directions along a route between a start point and an end point; receiving an indication that a user following the directions has become lost; identifying one or more points on or near the route; outputting the identified point(s) as options to the user; receiving a selection of one of the options from the user; and outputting one or more route directions from the selected point to the end point.

86. A method of providing route information, the method comprising defining one or more desired locations; and outputting a plurality of route schematics

which together provide a circuit route which starts and ends at the same point and includes each of the desired locations.

87. A method according to any of the preceding claims wherein the schematic or route information is presented to a user in a graphical form.

88. A method according to any of the preceding claims wherein the schematic or route information is presented to a user in a non-graphical form such as text or voice.

89. A method according to any of the preceding claims including determining the location of a device, the device including a user input device and a transmitter, the method comprising the steps of:
   a) receiving a location identifier from the user input device;
   b) transmitting the location identifier from the transmitter to a server;
   c) receiving the location identifier at the server; and
   d) determining the location of the device at least partially on the basis of the received location identifier.

90. A method of determining the location of a device, the device including a user input device and a transmitter, the method comprising the steps of:
   a) receiving a location identifier from the user input device;
   b) transmitting the location identifier from the transmitter to a server;
   c) receiving the location identifier at the server; and
   d) determining the location of the device at least partially on the basis of the received location identifier.

91. A method according to claim 89 or 90 wherein the device is a hand-held device.

92. A method according to any of claims 89 to 91 further comprising the step of performing a network fix on the device, and determining the location of the device on the basis of the network fix and the received location identifier.

93. A method according to any of claims 89 to 92 further comprising the steps of:
   a) transmitting a plurality of possible locations to the device;
   b) presenting the possible locations to the user;
   c) receiving a location selector from the user input device, the location selector identifying one of the possible locations;
   d) transmitting the location selector from the transmitter to a server;
   e) receiving the location selector at the server; and
   f) determining the location of the device on the basis of the received location selector.

94. A method according to any of claims 89 to 93 wherein the location identifier comprises a sequence of one or more letters, and the method further comprises selecting a plurality of possible locations each including the sequence of one or more letters.

95. A method according to any of claims 89 to 94 wherein the location identifier comprises a location category, and the method further comprises selecting a plurality of possible locations each falling within the location category.

96. A method according to any of claims 93 to 95 wherein the possible locations are presented to the user in graphical form.

97. A method according to any of claims 93 to 96 wherein the possible locations are presented to the user in textual form.

98. A method of searching a database, the method comprising the steps of:

a) searching the database to identify a number of database entries each including a sequence of *X* letters;

b) determining whether the number of database entries identified in step a) exceeds a predetermined maximum;

c) if the number of database entries identified in step a) is less than or equal to a predetermined maximum, then

i) transmitting the value *X* to a user input device,

ii) receiving a sequence of *X* letters from the user; and

iii) searching the database to select one or more database entries each including the input sequence of *X* letters; and

d) if the number of database entries identified in the step a) is greater than the predetermined maximum, then repeating steps a) and b) with a greater value for *X*.

99. A method according to claim 98 further comprising the step of outputting a pick list of database entries selected in step c)iii), and receiving a pick list selection from a user.

100. A method according to claim 98 or 99 further comprising performing a network fix on a device to determine the location of the device, and restricting the search in step c)iii) in accordance with the location of the device.

101. A method according to any of claims 98 to 100 further comprising outputting routing instructions to or from a location identified by the search.

102. A method of determining the location of a mobile device, the method comprising the steps of:

a) obtaining a coarse location fix defining a geographical area;

b) querying a data source to select points of interest which are located within the geographical area defined by the coarse location fix and which have stored criteria which indicate that the points of interest are likely to have a visibility to a user on the street which lies above a preset threshold;

c) outputting the selected point(s) of interest as options to the mobile device;

d) receiving a selection of one of the options from the mobile device; and

e) determining the location of the device at least partially on the basis of the selection received from the mobile device.

103. A method according to claim 102 wherein the stored criteria used in step c) include the size of the points of interest.

104. A method according to claim 102 or 103 wherein the stored criteria used in step b) include the classification of the points of interest.

105. A method of indexing geographical features in a map comprising providing a non-uniform grid of tiles representing the map, each tile representing a geographical area and including a list of features located in the geographical area.

106. A method according to claim 105, wherein large tiles are used to represent geographical areas with a low density of features, and small tiles are used to represent geographical areas with a high density of features.

107. A method according to claim 105 or 106 wherein several layers of tiles at successively lower resolutions are provided, such that in the highest layer a single tile covers a large area and lists all the tiles in the next layer which are enclosed within the area of the higher layer tile.

108. A method according to any of the preceding claims wherein the route information or schematic is generated and output from a central server; the method including receiving and displaying the route information or schematic at a mobile client device.

109. A system for performing the method of claim 108, the system comprising a central server configured to generate and output route information or schematics to a mobile client device; and a mobile client device configured to receive and display the route information or schematics.

110. A method of providing a schematic substantially as described herein with reference to any of the examples given in the accompanying drawings.

111. A method of providing route information substantially as described herein with reference to any of the examples given in the accompanying drawings.

112. Apparatus substantially as described herein with reference to any of Figures 1 to 3 of the drawings.

113. Software architecture substantially as described herein with reference to Figure 2 or Figure 3 of the drawings.

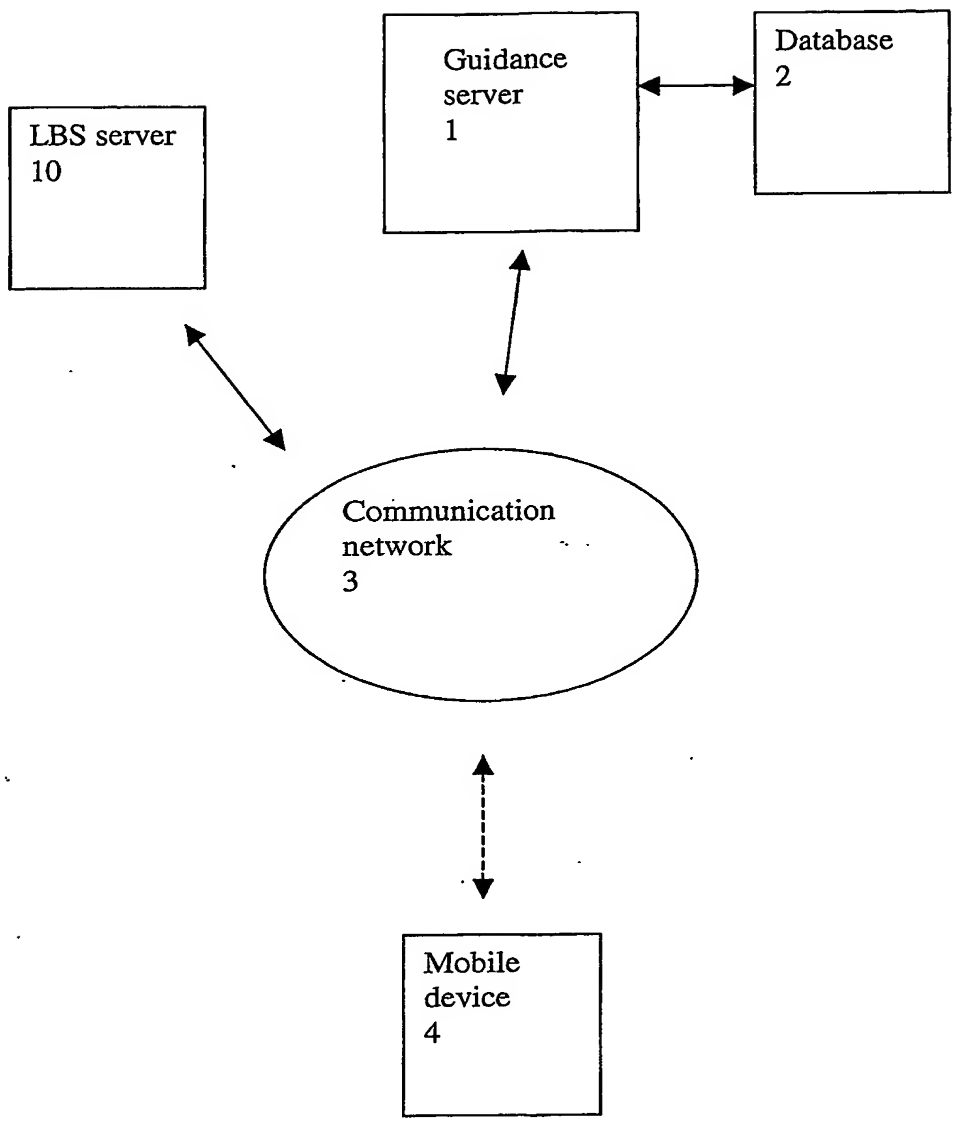

Guidance server 1
Database 2
LBS server 10
Communication network 3
Mobile device 4

Figure 1

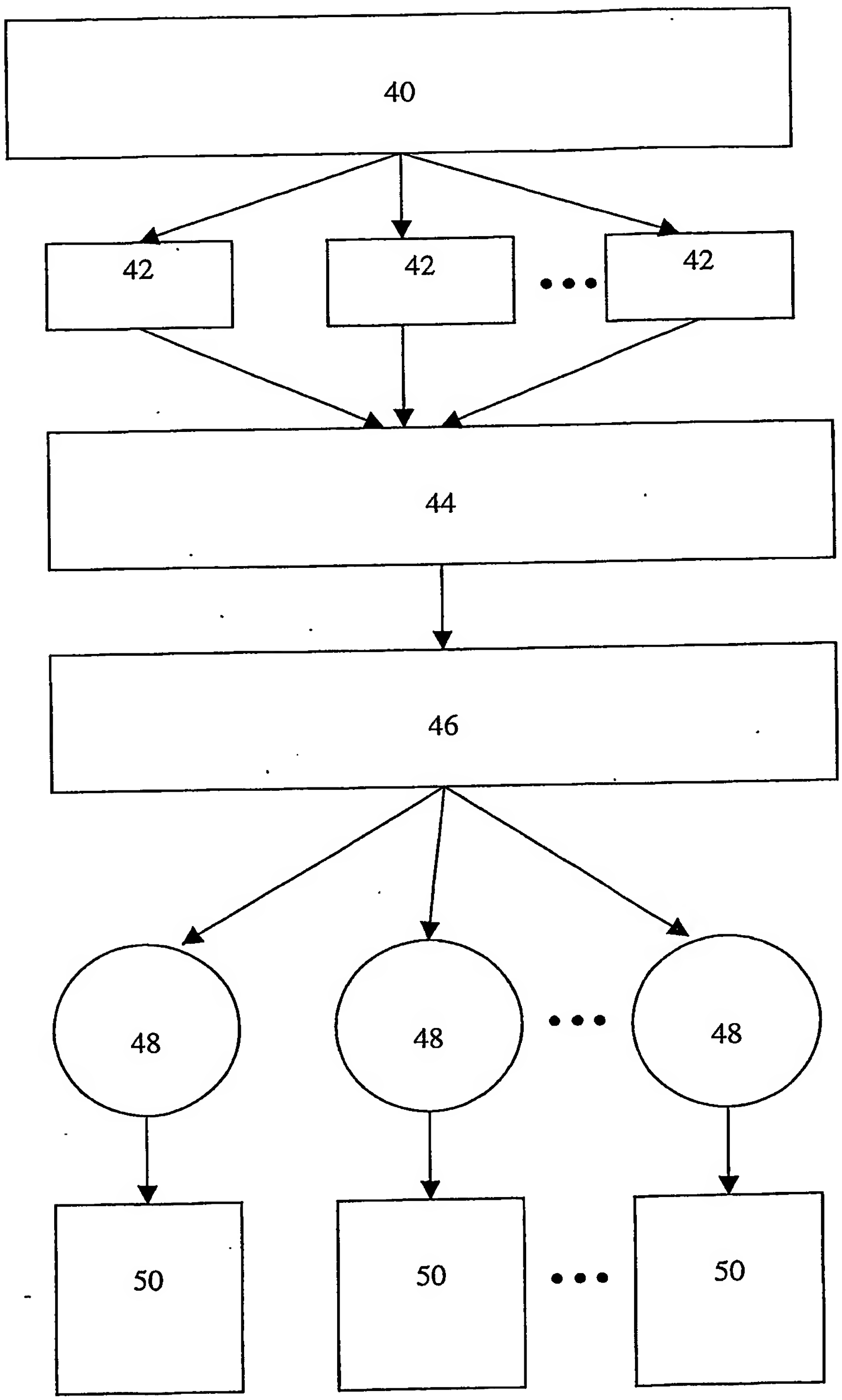


Figure 2

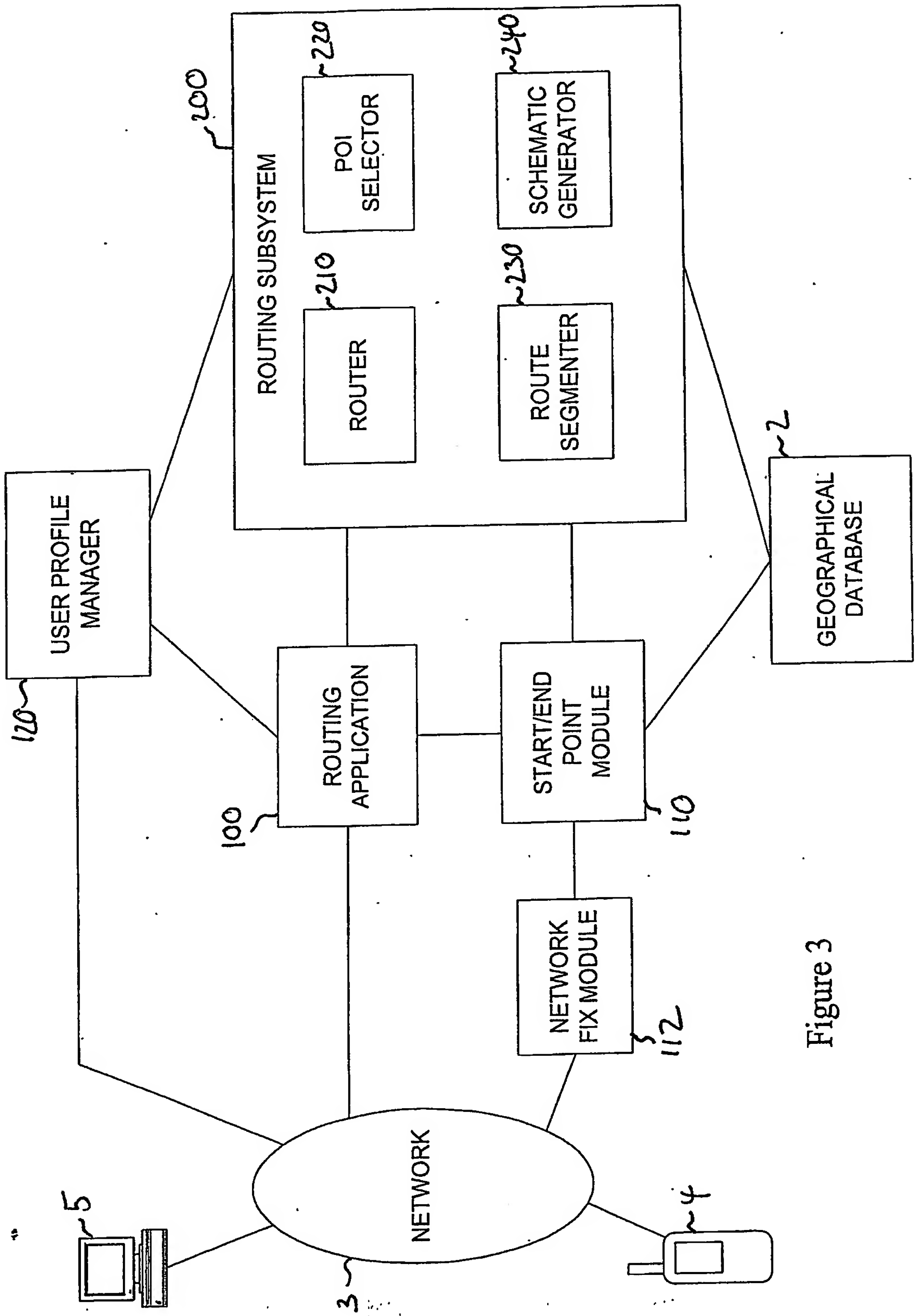

ROUTING SUBSYSTEM
200
POI SELECTOR
220
SCHEMATIC GENERATOR
240
ROUTER
210
ROUTE SEGMENTER
230
USER PROFILE MANAGER
120
GEOGRAPHICAL DATABASE
2
ROUTING APPLICATION
100
START/END POINT MODULE
110
NETWORK FIX MODULE
112
NETWORK
3
5
4

Figure 3

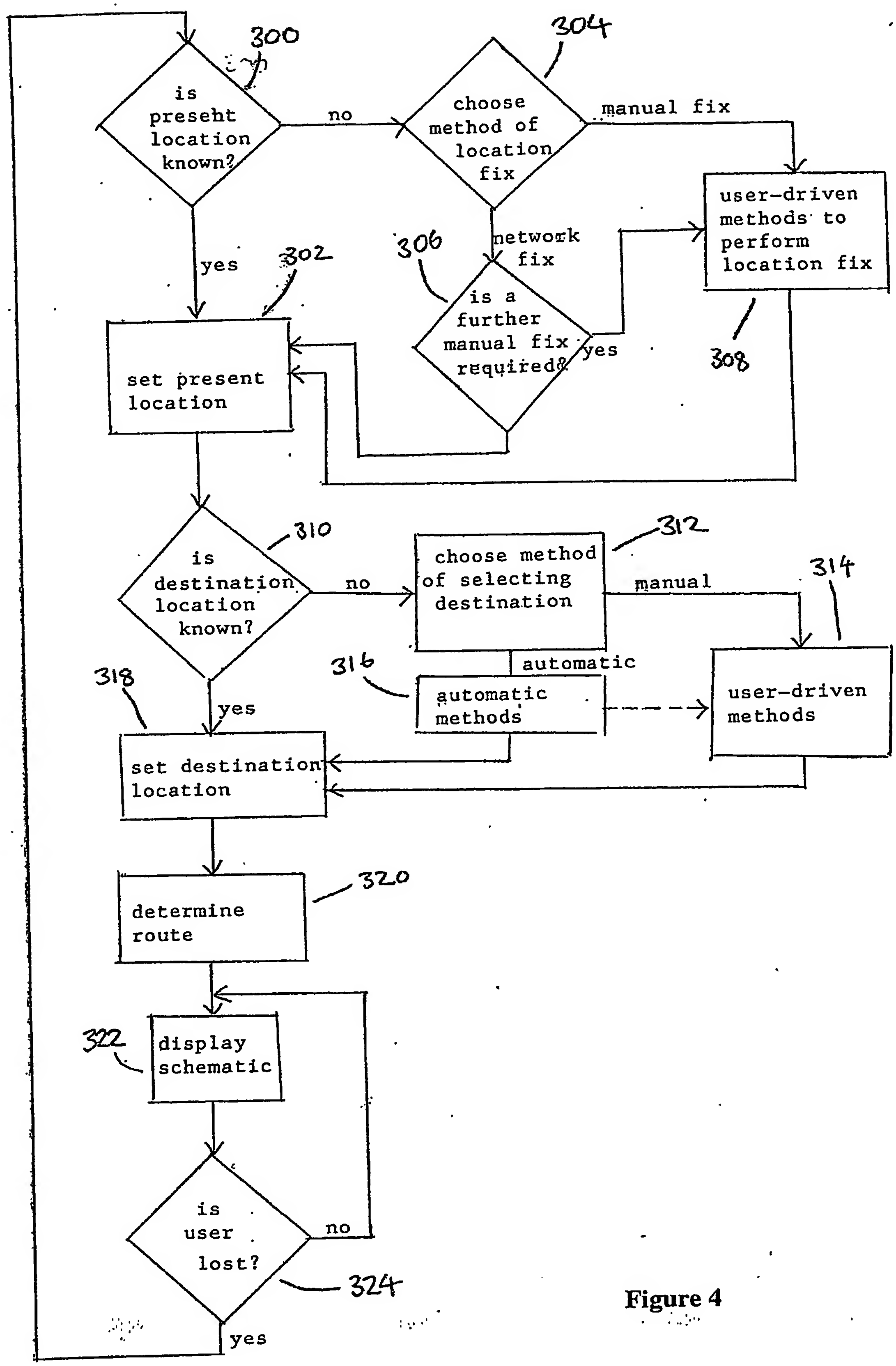

300
is present location known?
no
yes
304
choose method of location fix
manual fix
network fix
302
set present location
306
is a further manual fix required?
yes
user-driven methods to perform location fix
308
310
is destination location known?
no
yes
312
choose method of selecting destination
manual
automatic
314
316
automatic methods
user-driven methods
318
set destination location
320
determine route
322
display schematic
is user lost?
no
yes
324

Figure 4

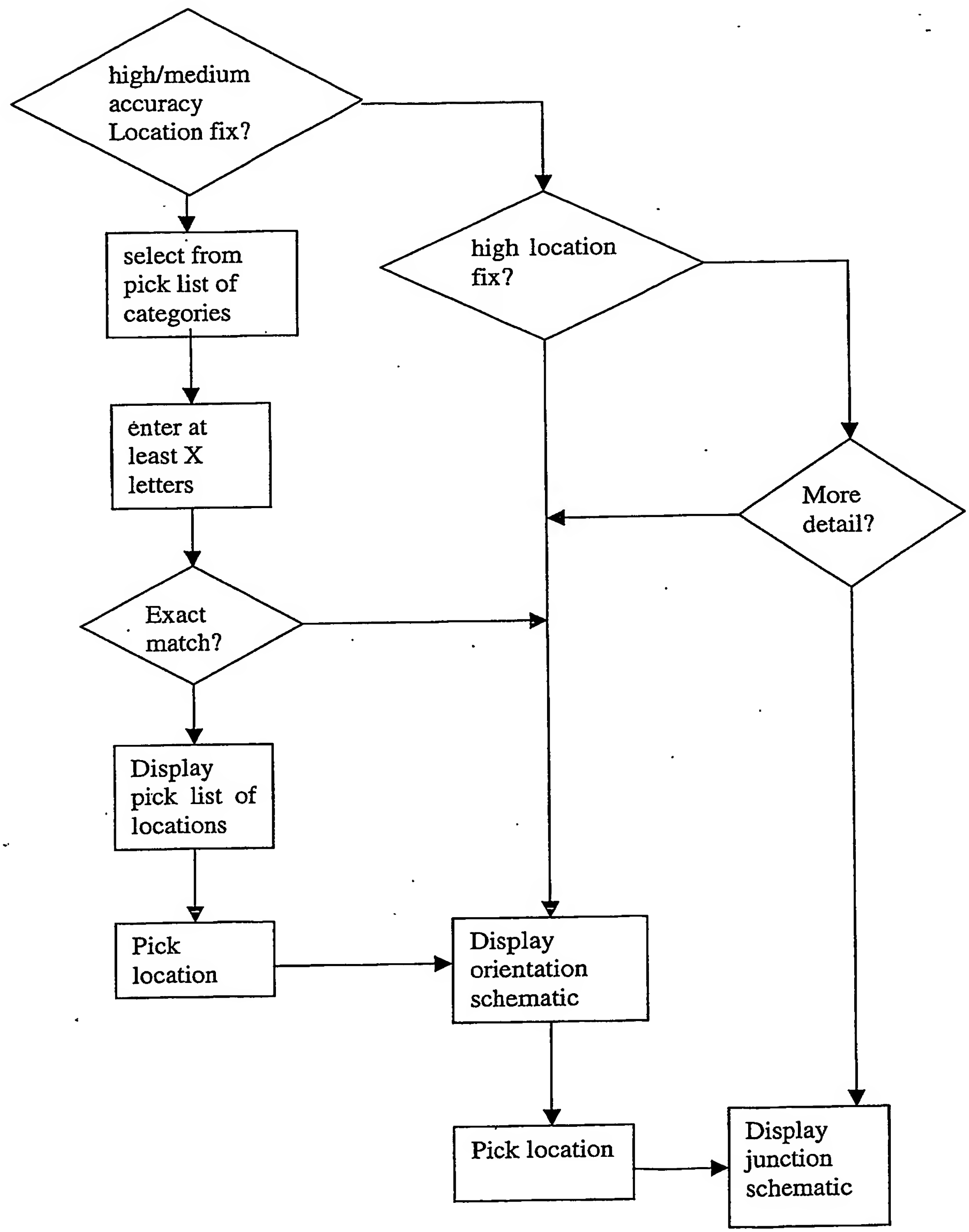
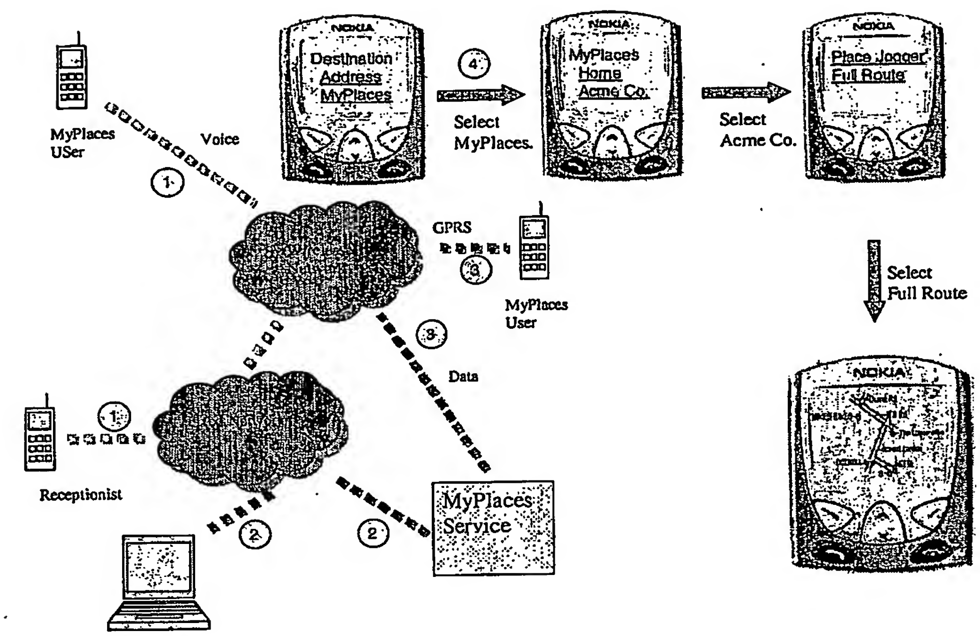

high/medium accuracy Location fix?
select from pick list of categories
enter at least X letters
Exact match?
Display pick list of locations
Pick location
high location fix?
More detail?
Display orientation schematic
Pick location
Display junction schematic

Figure 5



MyPlaces USer
Voice
Destination
Address
MyPlaces
Select MyPlaces.
MyPlaces
Home
Acme Co.
Select Acme Co.
Place Jogger
Full Route
GPRS
MyPlaces User
Select Full Route
Data
Receptionist
MyPlaces Service

Figure 6

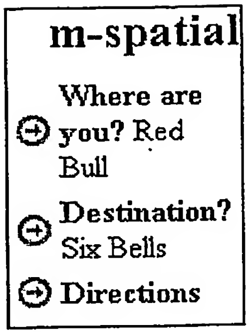


Figure 7

Figure 8

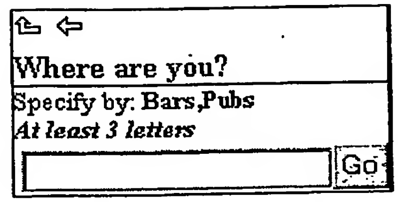


Figure 9

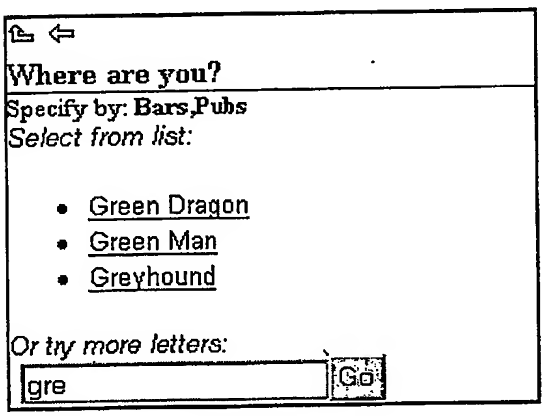


Figure 10

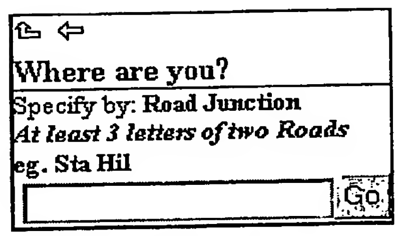


Figure 11

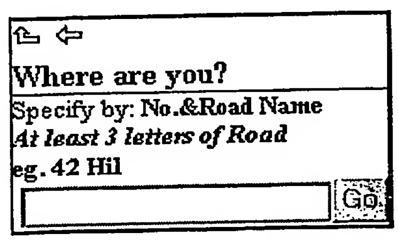


Figure 12

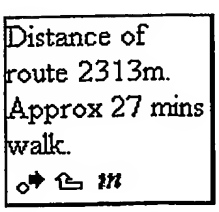


Figure 13

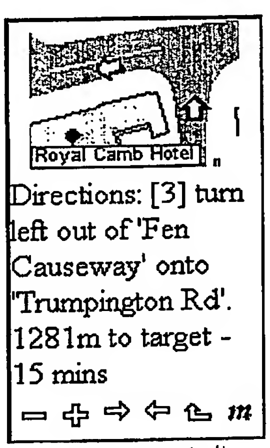


Figure 14

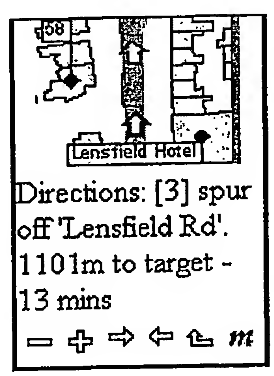


Figure 15

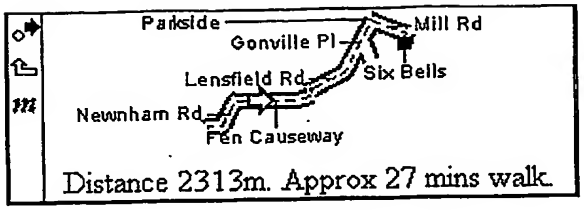


Figure 16

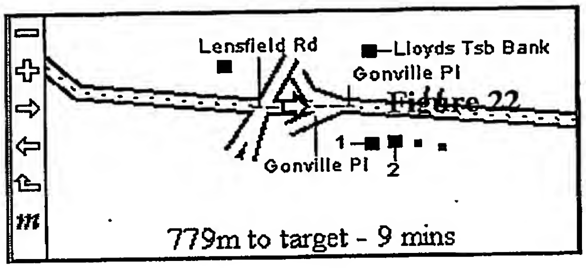


Figure 17

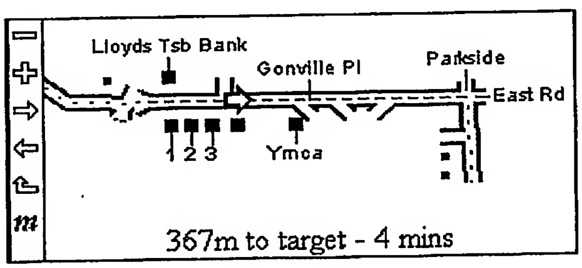


Figure 18

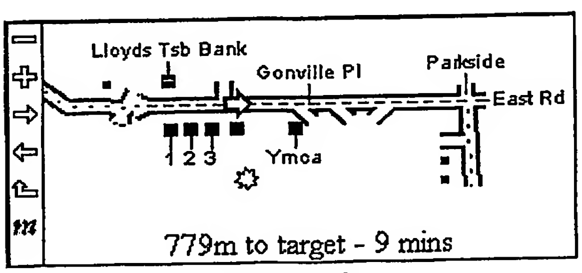


Figure 19

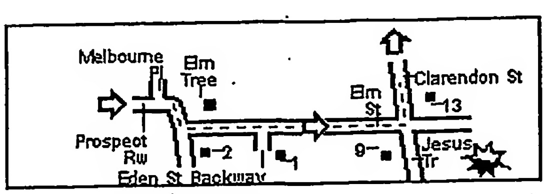


Figure 20

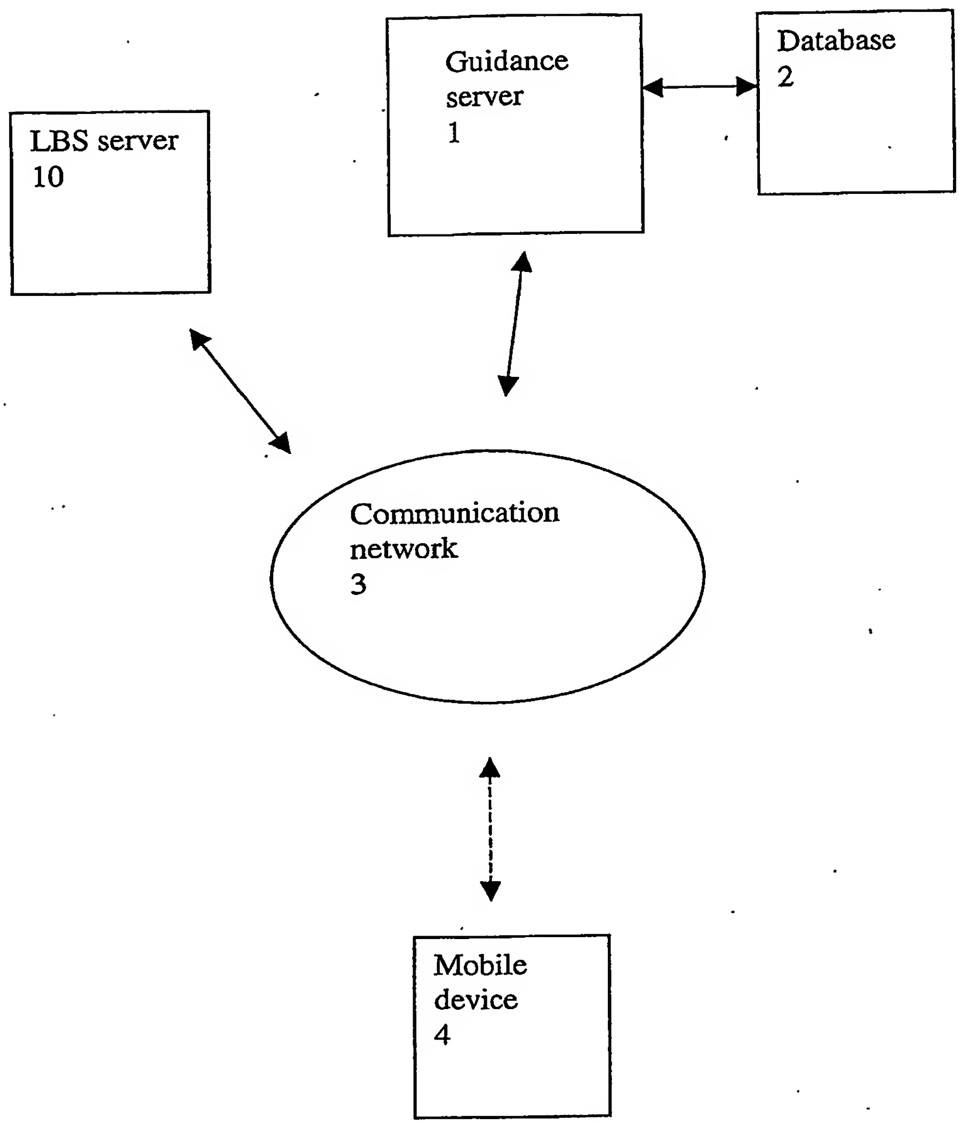

Guidance server 1
Database 2
LBS server 10
Communication network 3
Mobile device 4

Figure 1

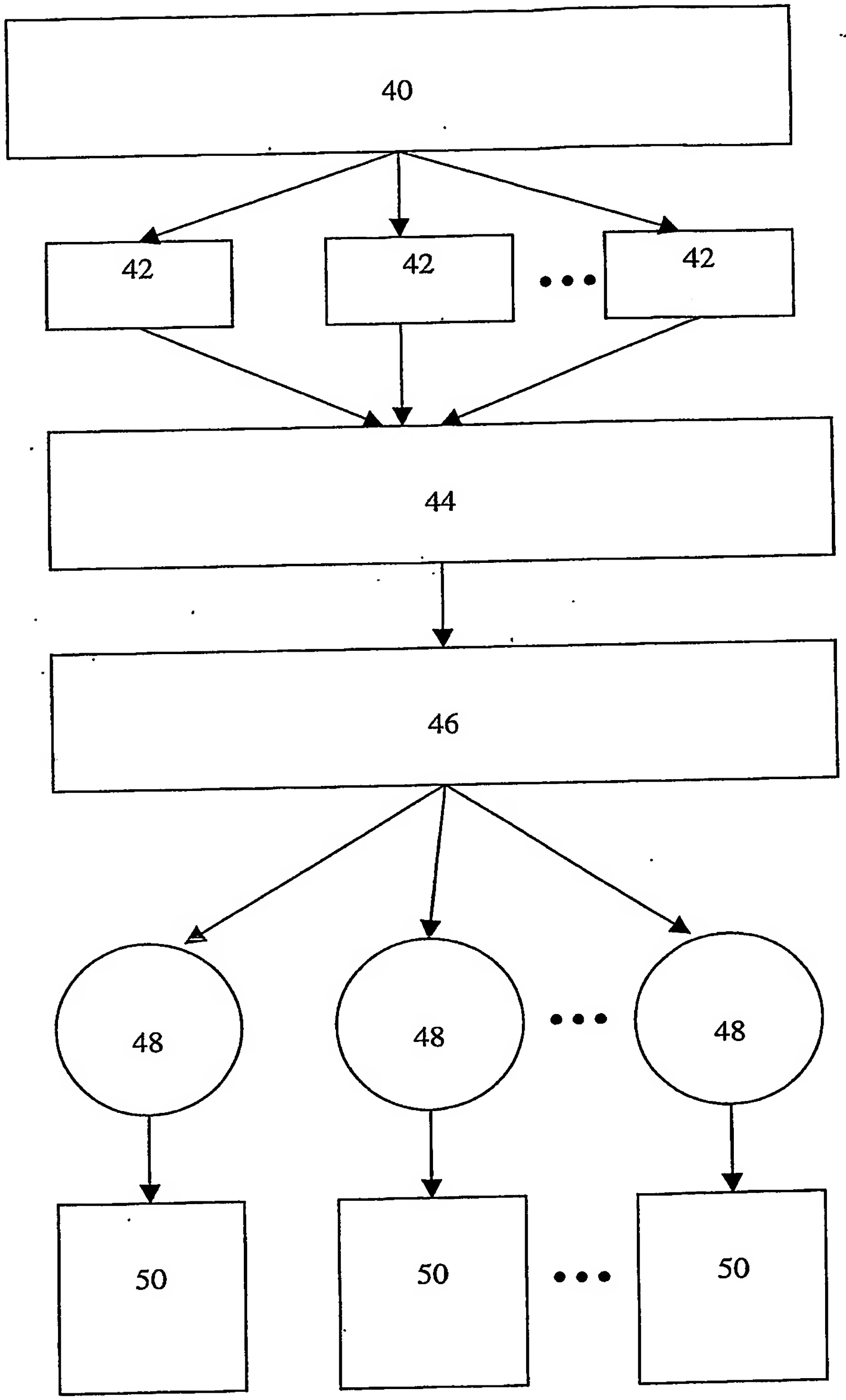
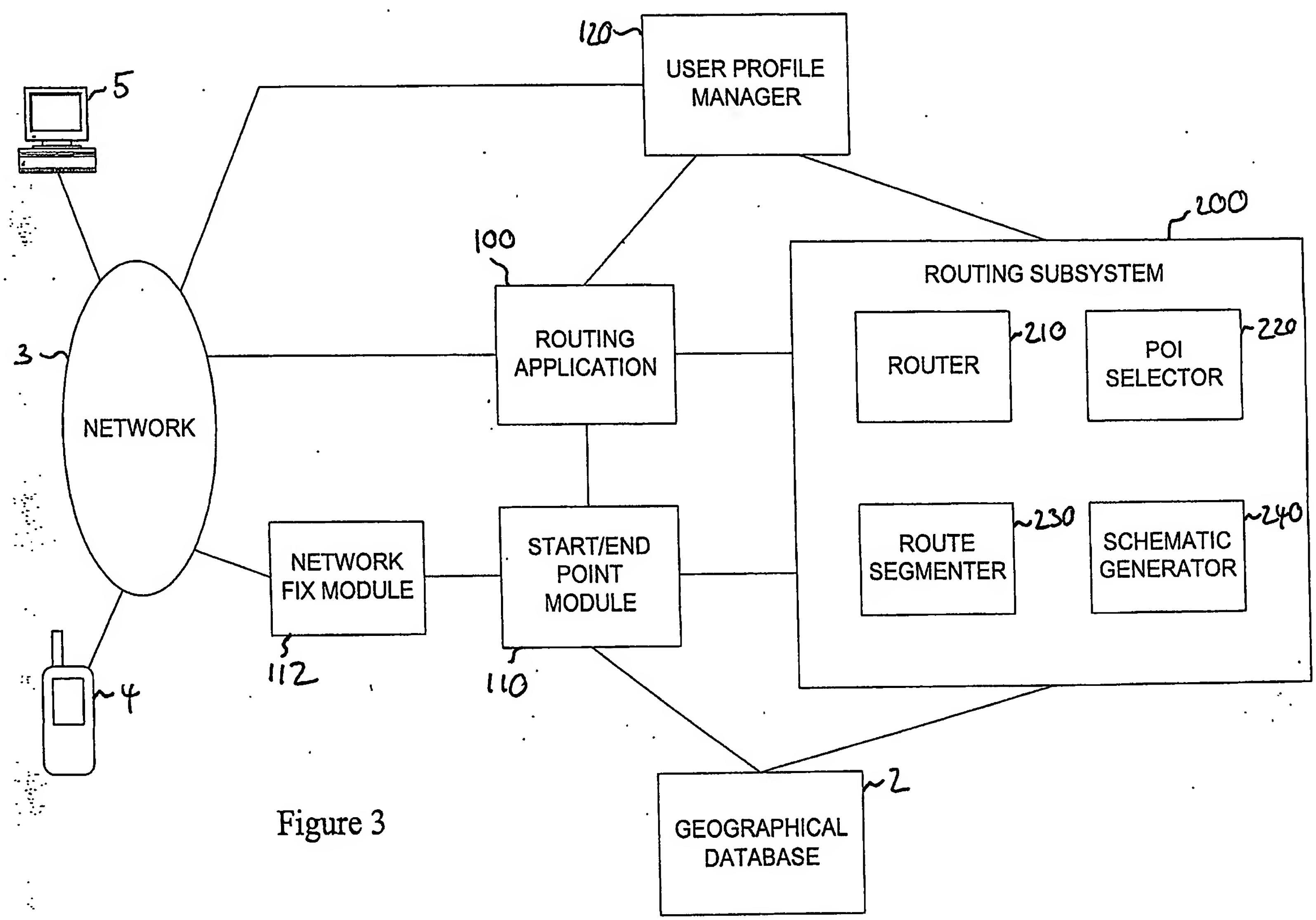


Figure 2



5
3
NETWORK
4
120
USER PROFILE MANAGER
100
ROUTING APPLICATION
NETWORK FIX MODULE
112
START/END POINT MODULE
110
200
ROUTING SUBSYSTEM
ROUTER
210
POI SELECTOR
220
ROUTE SEGMENTER
230
SCHEMATIC GENERATOR
240
GEOGRAPHICAL DATABASE
2

Figure 3

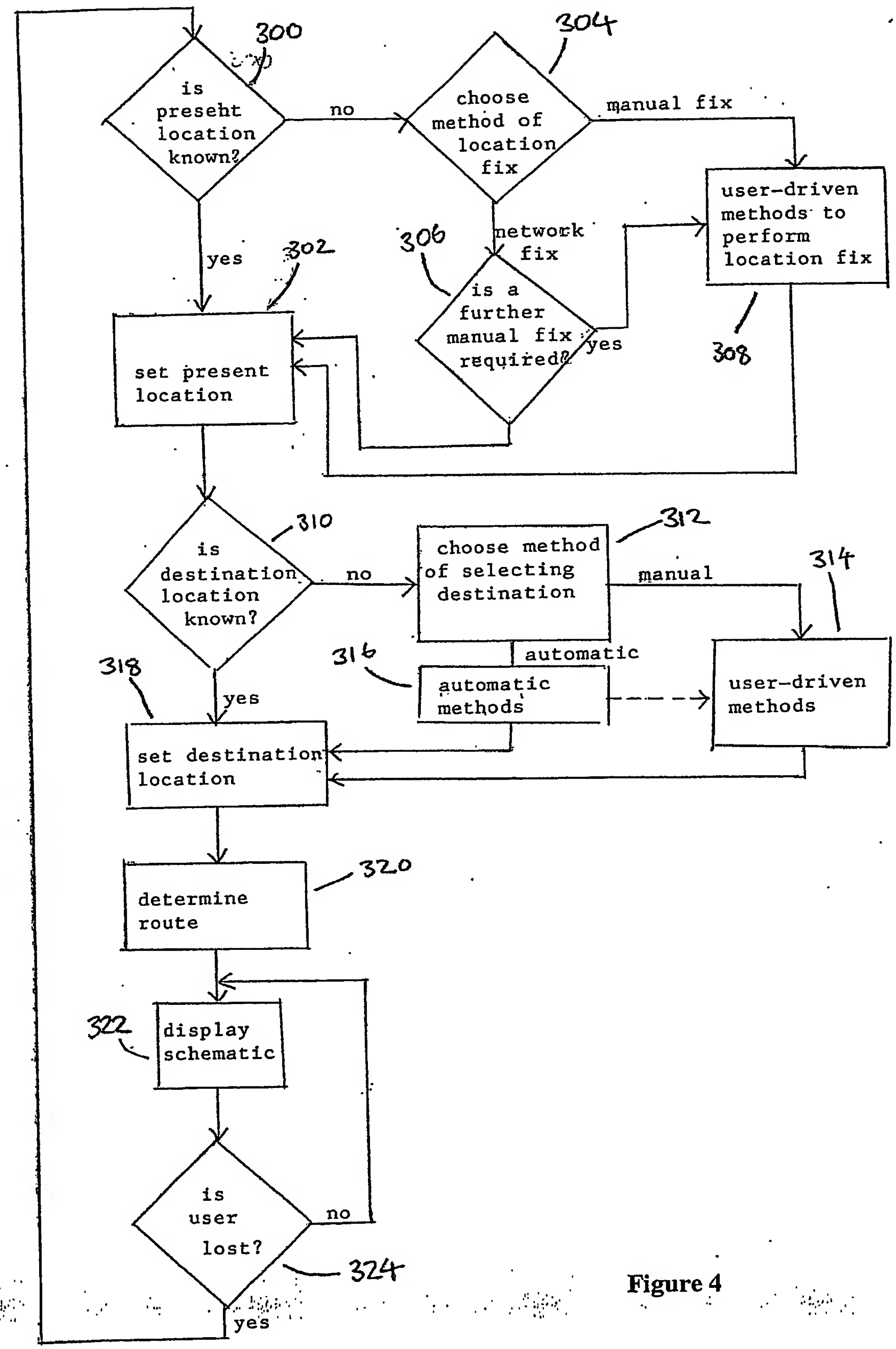

300
is present location known?
no
yes
304
choose method of location fix
manual fix
network fix
user-driven methods to perform location fix
308
306
is a further manual fix required?
yes
302
set present location
310
is destination location known?
no
312
choose method of selecting destination
manual
314
automatic
316
automatic methods
user-driven methods
318
yes
set destination location
320
determine route
322
display schematic
is user lost?
no
yes
324

Figure 4

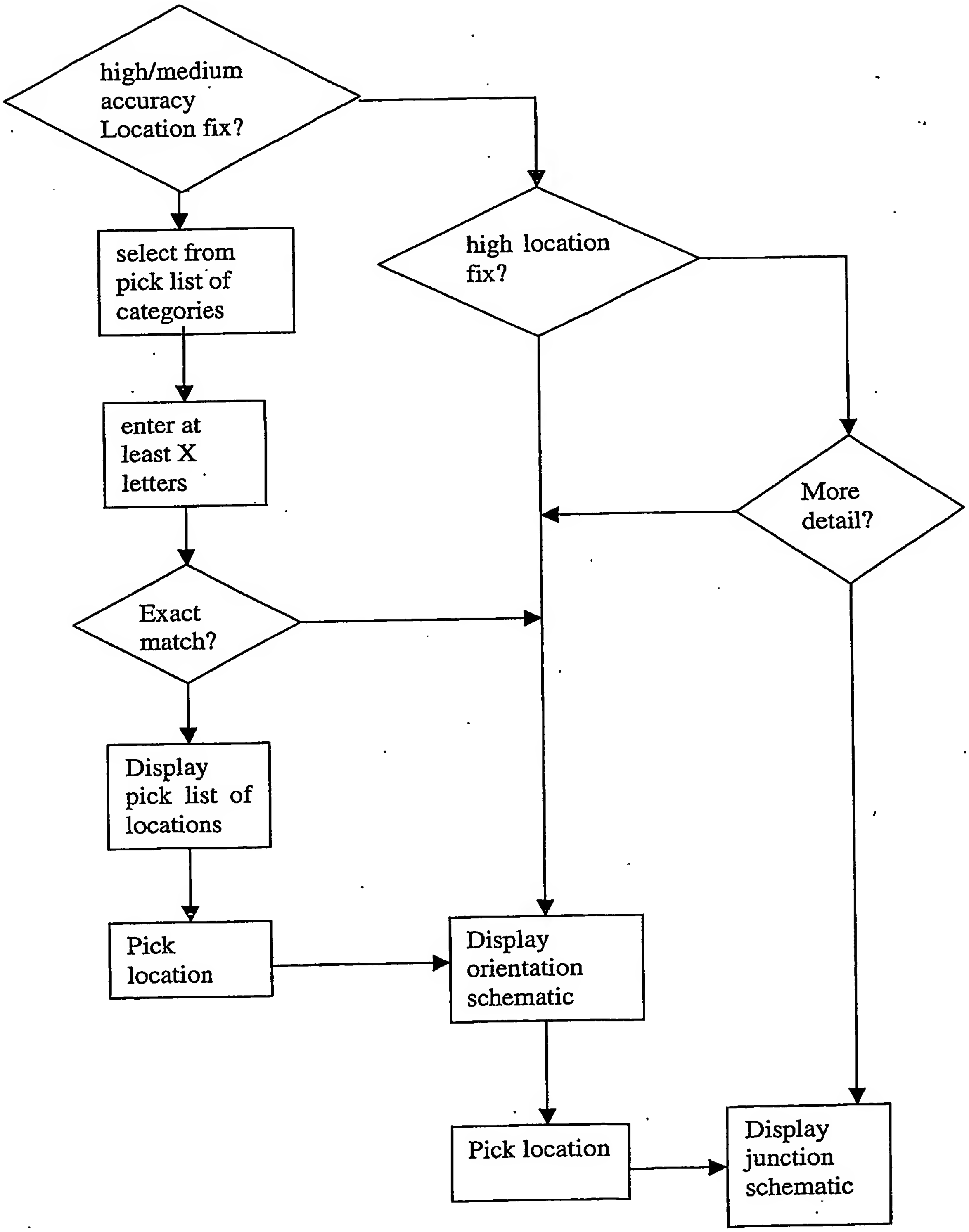

high/medium accuracy Location fix?
select from pick list of categories
enter at least X letters
Exact match?
Display pick list of locations
Pick location
high location fix?
More detail?
Display orientation schematic
Pick location
Display junction schematic

Figure 5

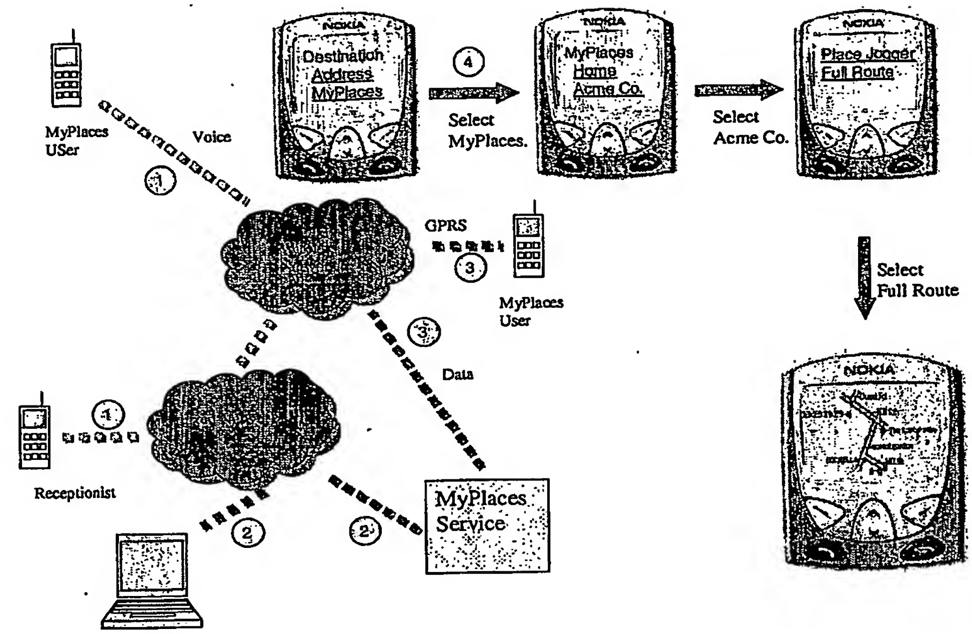

NOKIA
Destination
Address
MyPlaces
4
Select
MyPlaces.
NOKIA
MyPlaces
Home
Acme Co.
Select
Acme Co.
NOKIA
Place Jogger
Full Route
MyPlaces
USer
Voice
1
GPRS
3
MyPlaces
User
Select
Full Route
3
Data
NOKIA
1
Receptionist
MyPlaces
Service
2
2

Figure 6

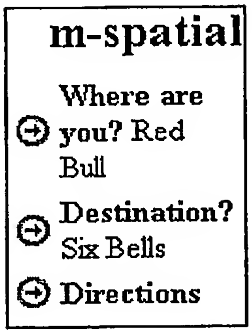


Figure 7

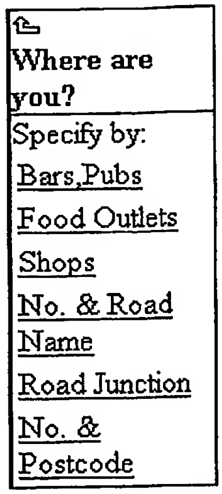


Figure 8

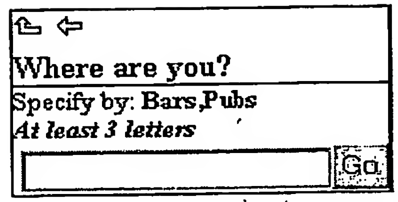


Figure 9

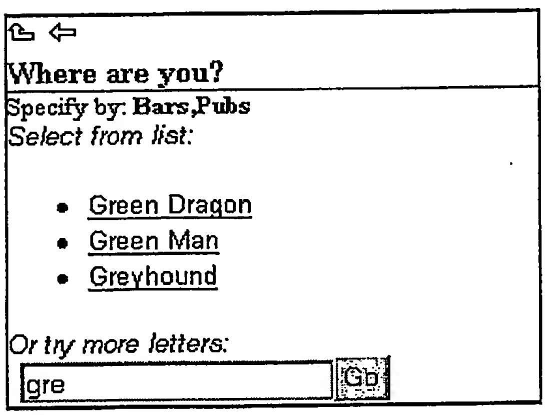


Figure 10

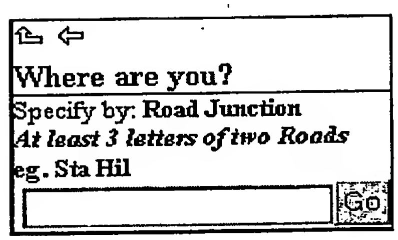


Figure 11

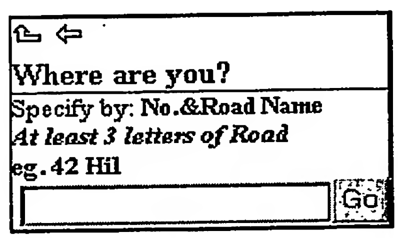


Figure 12

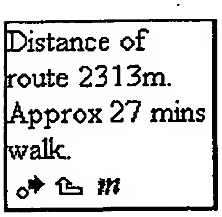


Figure 13

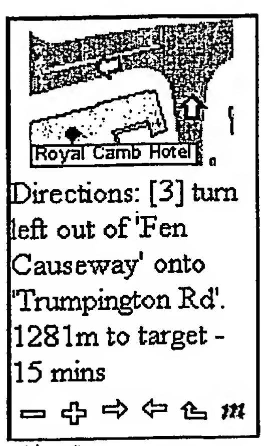


Figure 14

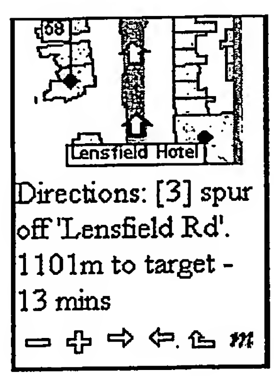


Figure 15

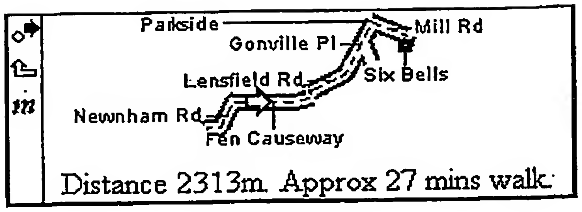


Figure 16

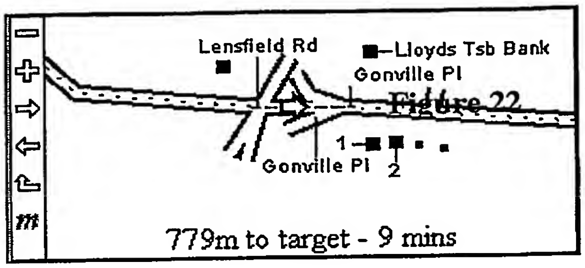


Figure 17

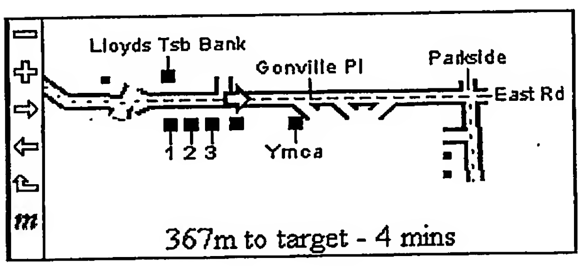


Figure 18

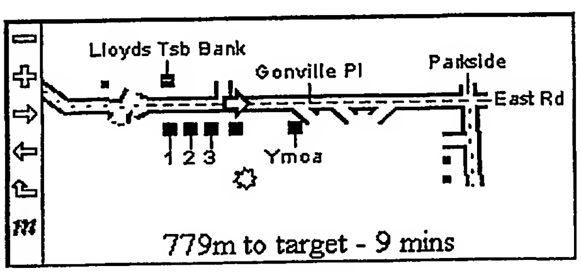


Figure 19

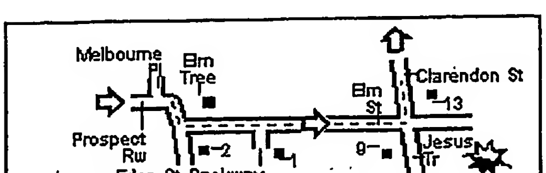
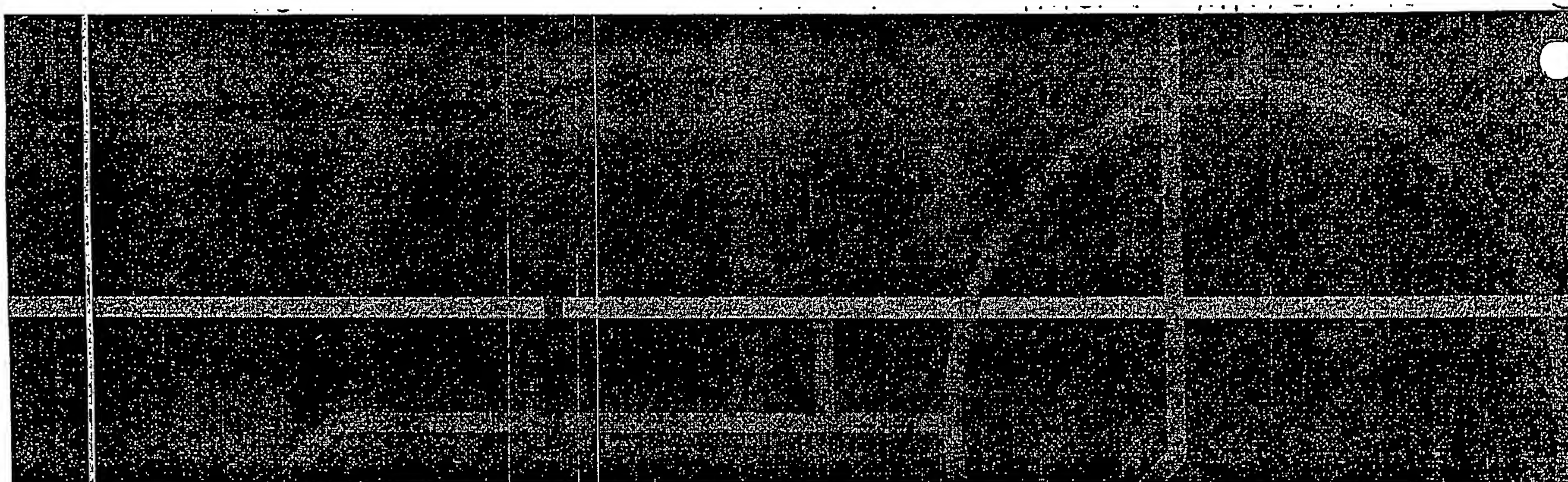


Figure 20



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The m-spatial Proposition

Andy Walker – Marketing Director and Acting CEO

Agenda

- → Introduction to m-spatial
- → The mobile telecoms landscape
- → Barriers to adoption for new services
- → The concept of "where?"
- → m-spatial's role
- → Routing and Guidance
- → What's special about m-spatial?

Introduction to m-spatial

- Founded June 2001
- First round funding £1.2m
  - 3 prominent Venture Capitalists
    - Prelude, Alta-Berkeley, Delta Partners
- Strong management team from GIS and Telecoms Industries
  - Jon Billing and Adrian Cuthbert – Laser-Scan
  - Andy Walker - Vocalis

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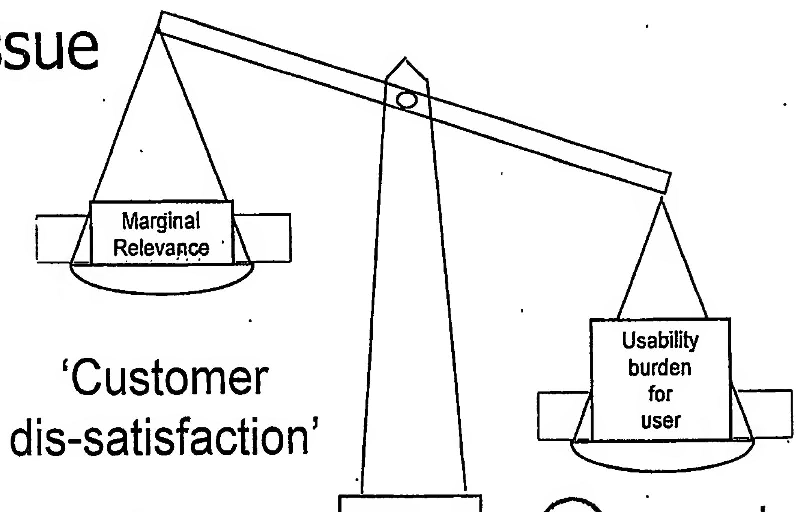
The Mobile Telecoms Landscape

- Many markets reaching saturation
  - Emphasis is now more on:
    - Customer retention
    - Revenue per customer
- New Value added services are now key
  - Ultimately 3G...
  - ...but lots of potential with 2G and 2.5G
  - Extended use of SMS is gaining ground
  - Location based services (LBS) are a prime candidate

Barriers to adoption for new services

- → Mobile Internet concept is facing significant challenges
  - → Services must be relevant to the mobile context
    - → Many of the initial services have simply provided access to a fixed internet site from a mobile terminal
  - → Usability is a significant issue
    - → WAP can be a poor user experience



'Customer dis-satisfaction'

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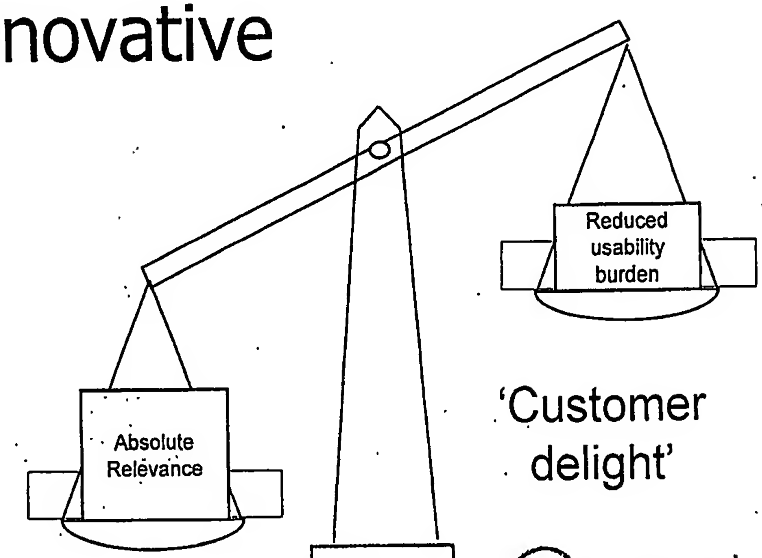
Removing the barriers

- Services including the concept of "where?" can offer much improved relevance
  - Users often need to know the answer to this question 'on the street'
- Usability issue requires innovative technology to address:
  - Limited user input
  - Restricted display



'Customer delight'

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The concept of "where?"

- The need to know "where?" is a basic human need
  - Where to meet socially, for business, where to buy things...the list goes on
- There are some content rich LBS – but text based usability is poor
- The answer to the question "where?" is often best expressed graphically
  - We've all scribbled maps on the back of an envelope

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m-spatial's role

"Providing a uniquely usable answer to the question 'where?' on mass market mobile devices"

Answers to the question "Where?"

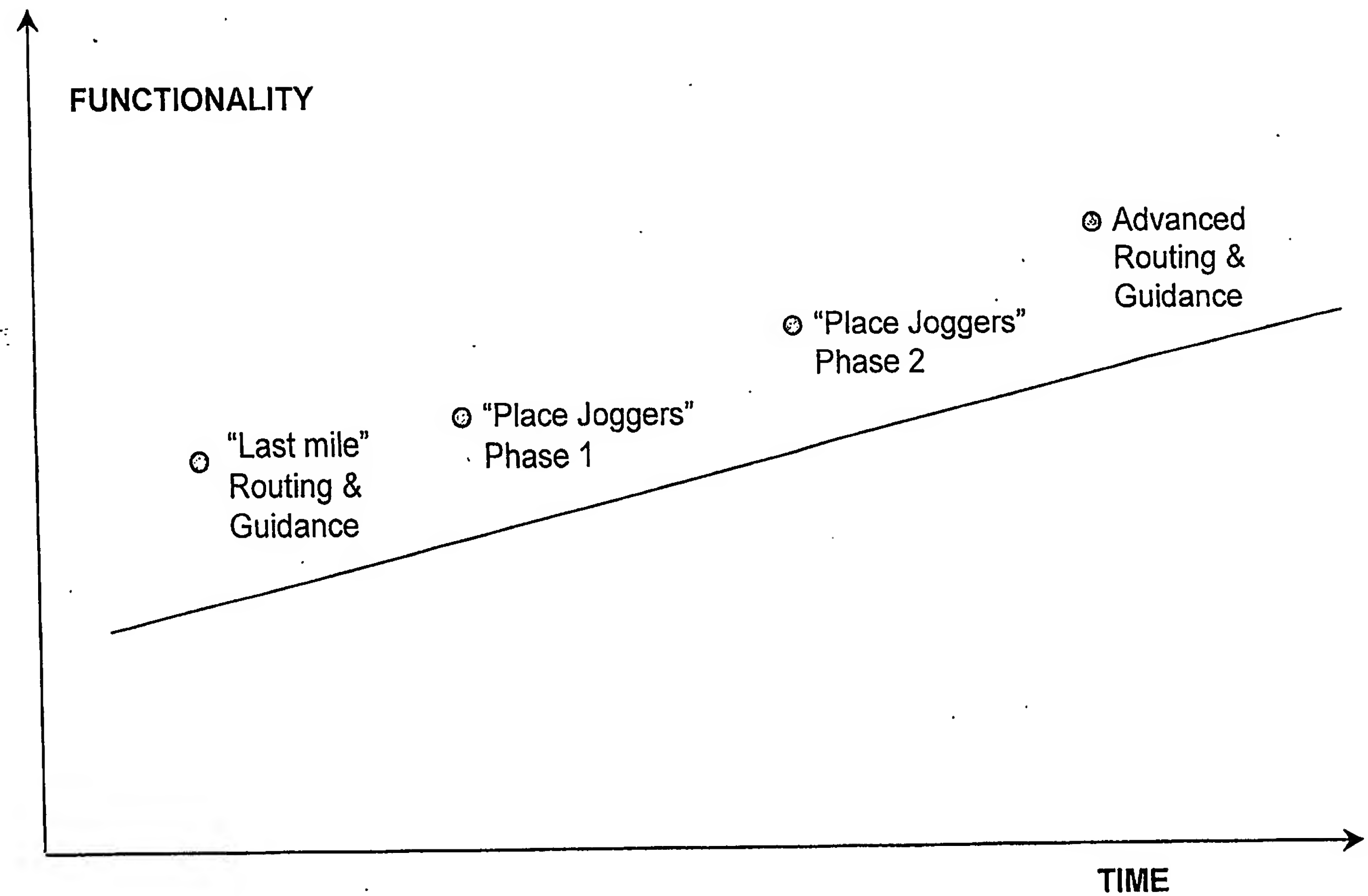
- The name of the location might be enough
  - e.g. The Red Lion
- Many people might require a memory jogger
  - e.g. The Red Lion is 5 mins walk from Cockfosters tube station
  - A map of the immediate surrounding area
- A further group would require full directions
  - Step by step routing and guidance must be provided

The technical challenge

- To provide a representation of "where?" suitable for the input and output capabilities of a mass market device
  - Simply delivering a map segment to small device is not usable

"m-spatial's proprietary technology dynamically produces sketch maps customised to the area and/or route being displayed and the device being used"

Product Evolution



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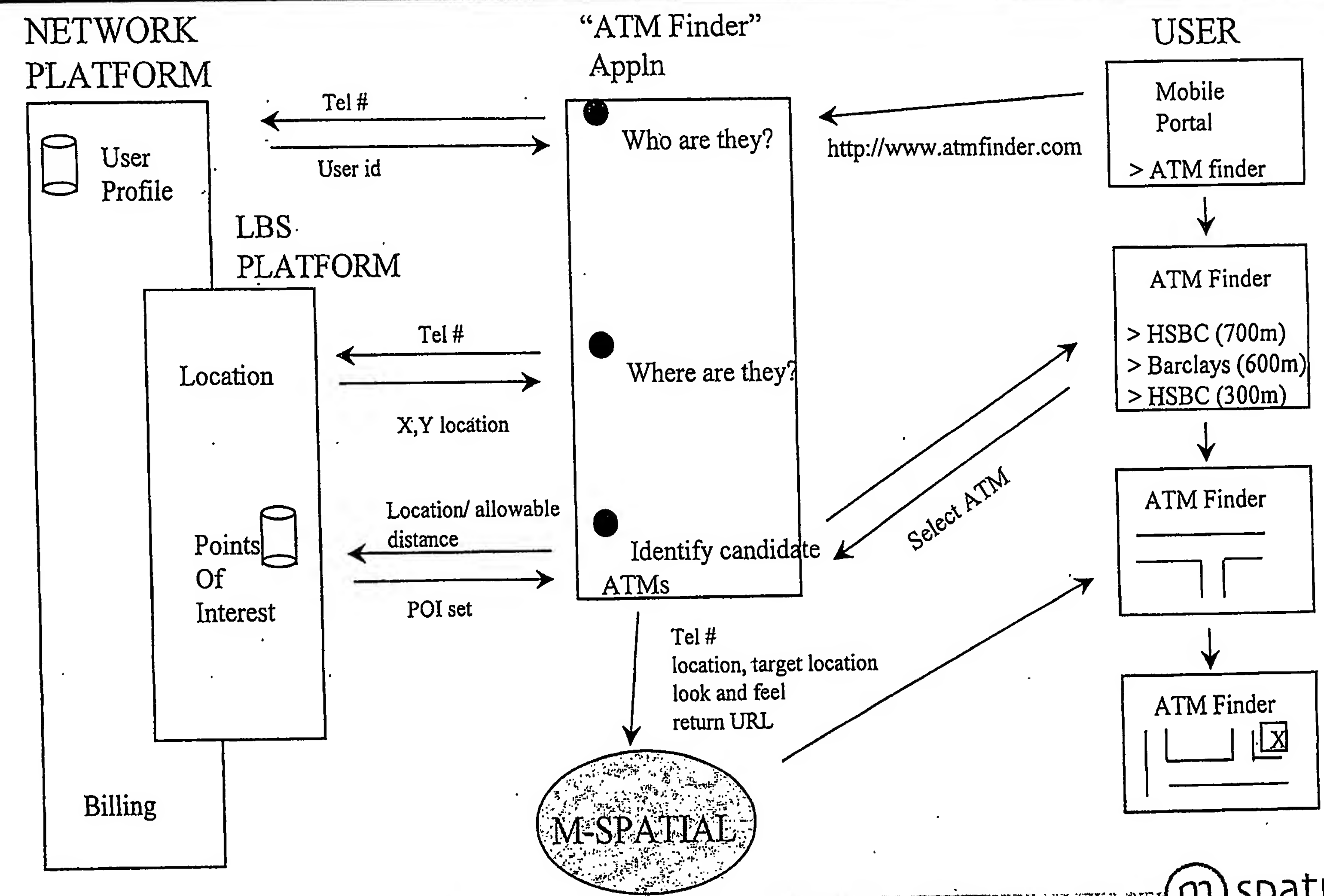
Product Form

- A component technology that can be used by applications to represent the answer to the question "where?"
  - An individual function within the network
  - High level task oriented API
  - Managed Service – via an internet API
    - For evaluation and development
  - Onsite installation – for rollout

m-spatial's role
How do we fit in?



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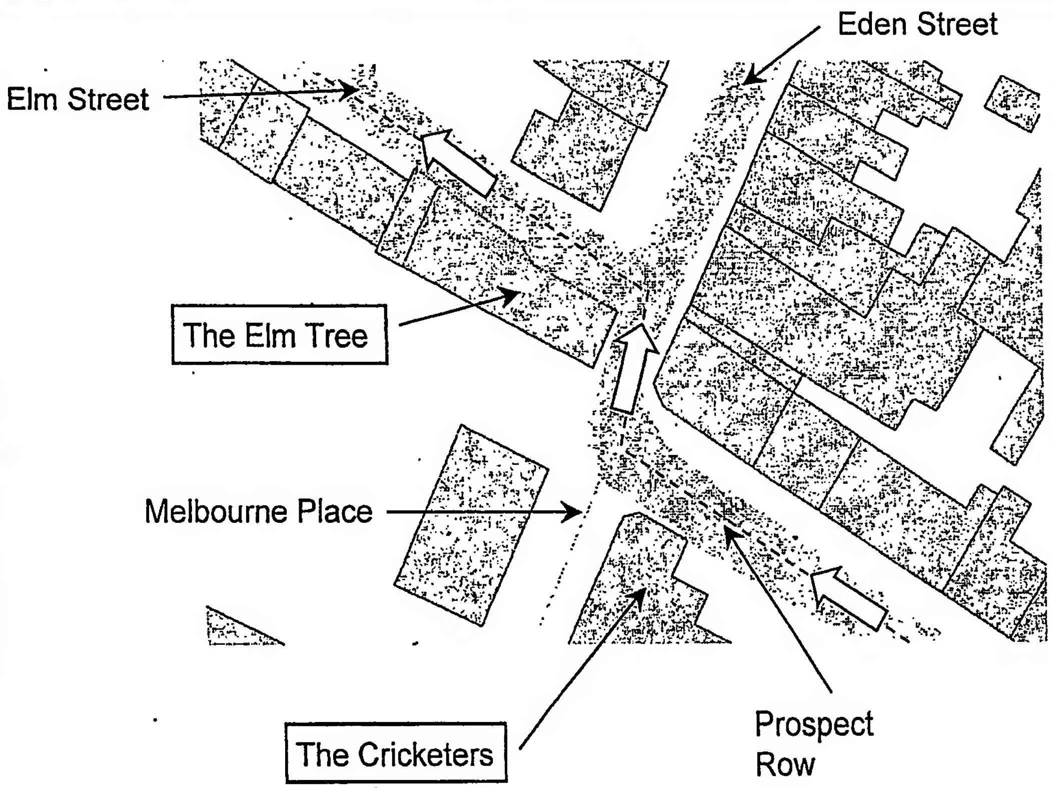
Routing and Guidance
The Market Opportunity

- Many journeys involve a pedestrian "final approach"
  - User may be separated from their in-car navigation system (if they have one)
  - Could be from a tube station/a car park etc.
  - You never have a map when you need one
- The opportunity is to provide a ubiquitous usable technology that works across the spectrum of mass market mobile devices and applications

Routing and Guidance

Text versus Graphics Example



TYPICAL TEXT DIRECTIONS

"Go 0.08 miles on Prospect Row and turn left into Elm Street"

REAL WORLD ISSUES

- Have to bear right before turning left
- No road sign on entry to Elm Street
- No road sign on entry to Melbourne Place

LIKELY EFFECT

Pedestrian incorrectly chooses to walk down Melbourne Place

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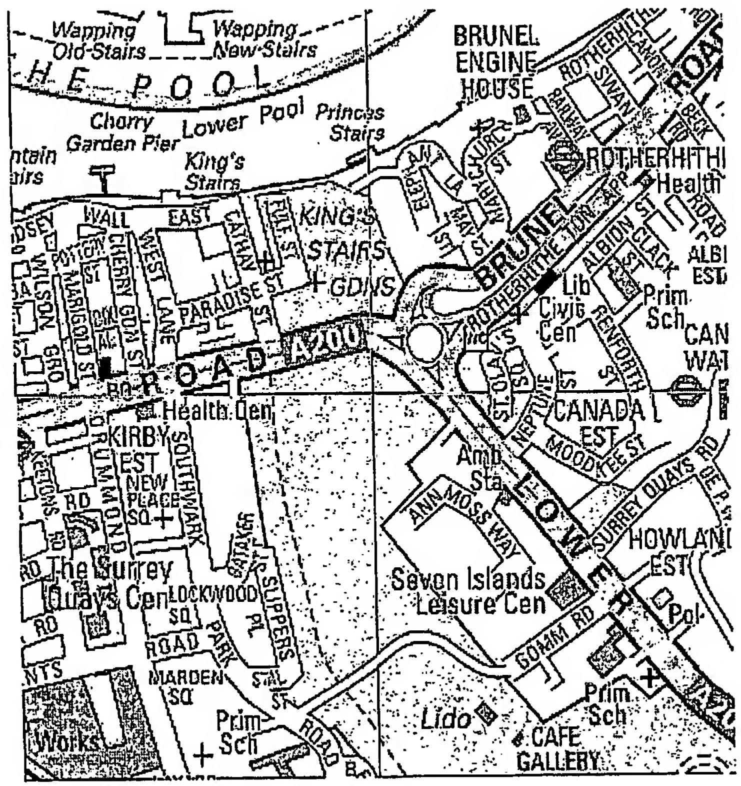
Maps versus Schematics

A typical raster map



Strictly Confidential

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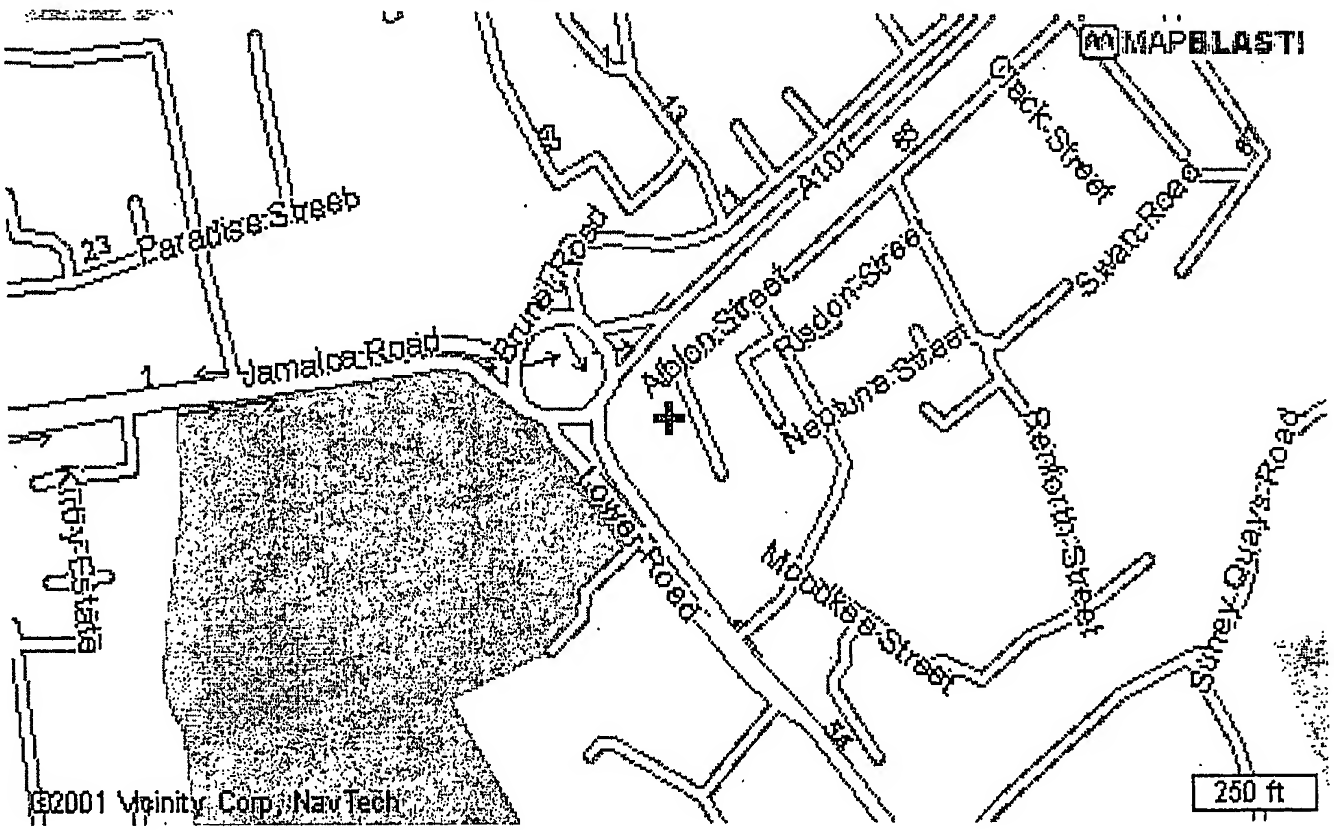
Maps versus Schematics

A typical Vector map (same area)



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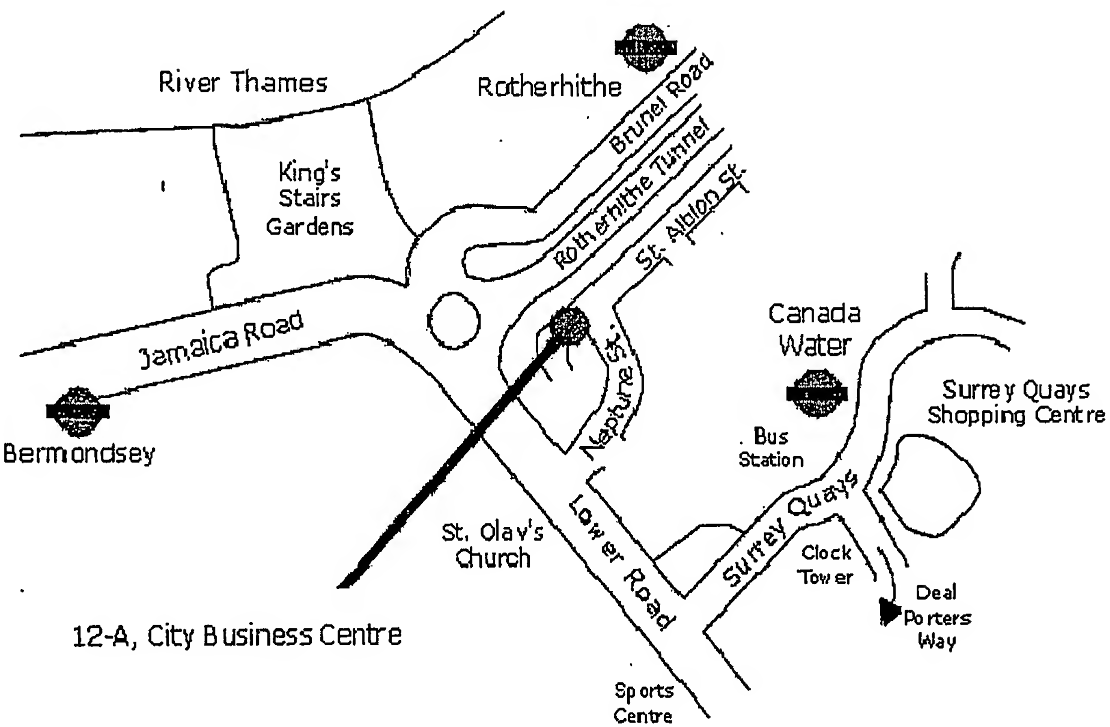
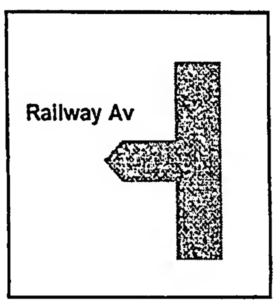
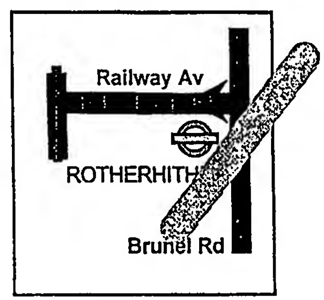
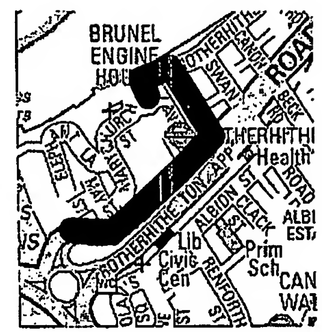
Maps versus Schematics

A schematic of the same area

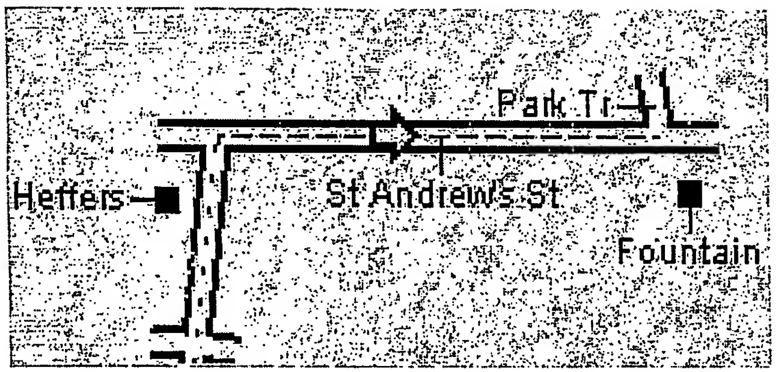


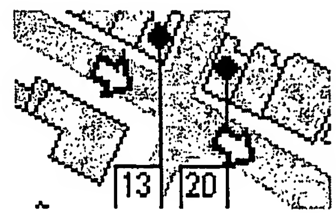
The Technology Continuum

Not Enough Detail	Variable Detail	Too Much Detail
Confined to roads involved in junctions	On and around the route	None-selective display
"Turn left into Railway Avenue"	"Turn left into Railway Avenue just after Rotherhithe Tube Station"	
OR	OR	
		
in-vehicle systems	m-spatial technology	raster maps

Displaying on a mobile device

Approach varies with size of screen





Larger Screen Devices

Works with expected form factor for high end phones from mid 2002 (example above is R380, same approach works with squarer screens)

Smaller Screen Devices

Matches current phones

Routing and Guidance

What's special about m-spatial?

- Extensive effort spent exclusively on successful delivery of directions for pedestrians on mobile phones
  - Extensive user trialing
    - Schematics work better than maps
    - Features important for display are different to in-car directions
  - Application specific back end environment
  - Significant effort in use and integration of real world positioning technologies

Place Jogger
The Market Opportunity

- Not everyone needs step by step directions
  - Given an address or name of a location, a simple map showing the destination relative to significant local landmarks may be enough
- This saves time and money for the service user
  - Lower cost than a full route
  - Just needs a single glance before the start of the final leg of the journey – no need to continually refer to it

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Place Jogger

The technical challenges

- Again an extracted map segment is not viable for a mass market phone
- The representation is best stylised
  - i.e. most often not to scale
  - Limited landmarks carefully picked to be significant and likely to be well known
  - A very limited number of roads shown – again according to likelihood of being known
  - c.f. a cut down version of a typical "how to find us" sketch map on a web site

Maximising Usage
The challenges

→ Many mobile phone users aren't regularly lost – but do follow routes inefficiently due to lack of information

"The key is to make a service offering place-joggers and routing & guidance as easy to access and use as possible – and to ensure it is in the mind of the user when they might need it "

Easing User Access
Pull Services (1)

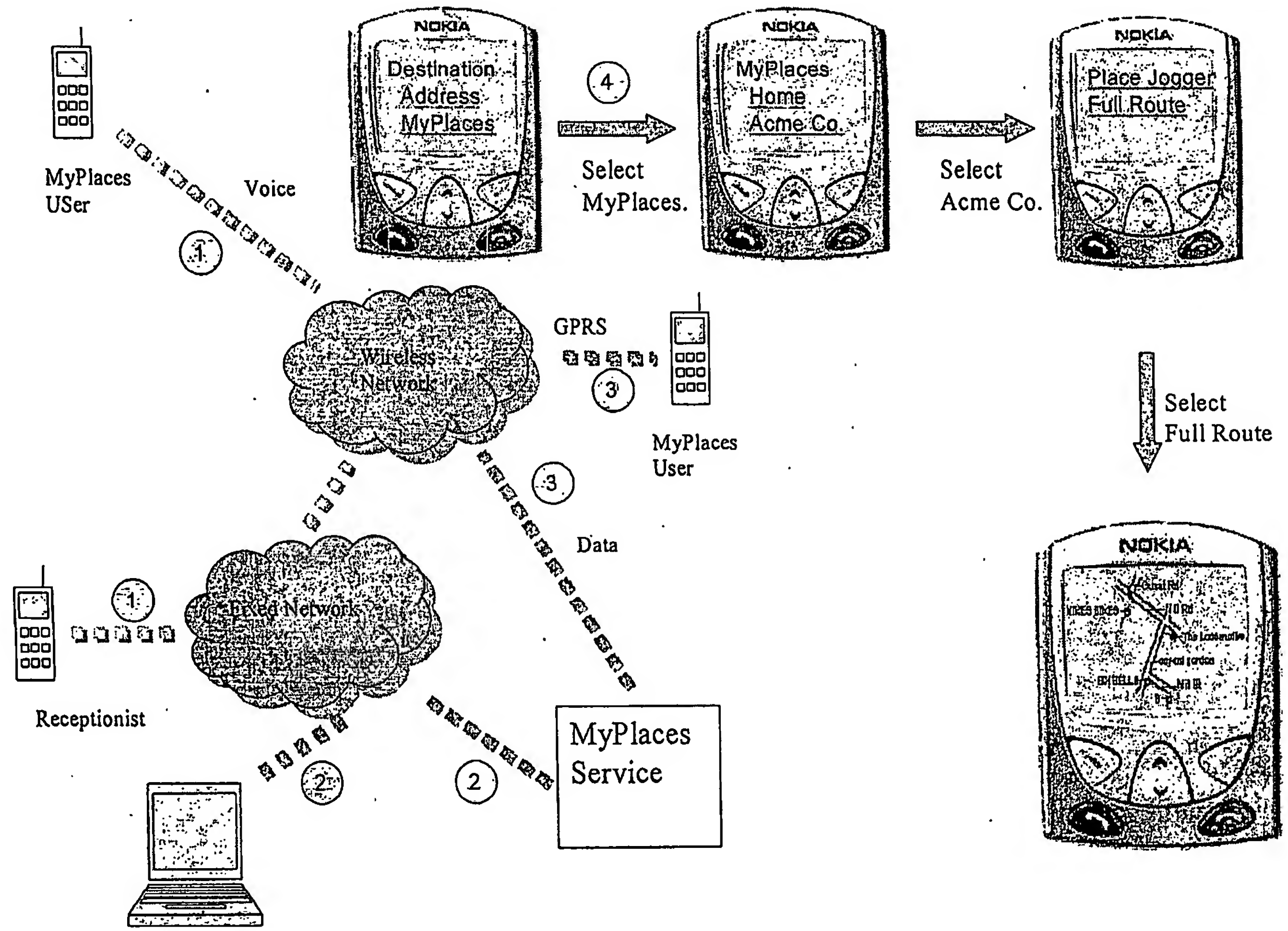
- Generally options on a major portal
  - Generic "how do I get to" application or as part of the functionality of 3rd party applications such as "Find my nearest"
- Require the user to actively access the service
- Use can be prompted externally
  - Adverts aimed at tourists or visitors to an area
    - Public transport termini, car parks etc.
- Specification of destination is most complex step

Easing User Access
Pull Services (d)

- ➔ Simplification of destination specification
  - ➔ Default mechanism is via WAP menu and text input
  - ➔ Key initial simplification is ability to pick from a pre-populated MyPlaces list
    - ➔ Entries can be generated from various sources
      - ➔ Module may be added to say a retail web site that allows the service user to enter their mobile phone number and have the retail location automatically added to their MyPlaces list
      - ➔ User or 3rd party can enter addresses/locations on a web site on the fixed internet associated with the service - for journey preparation
        - ➔ E.g. receptionist can add their office location onto the MyPlaces list of a traveling visitor who can't find their office

Easing User Access

MyPlaces example



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Easing User Access
(Push Services (1))

- Here the use of the service is instigated by a user for interpretation of a received 'location tag'
- Requires emergence of a standard for associating location information with entities passed by communication
  - i.e. the ability to nominate text in an SMS as having a location e.g. "The Red Lion".
  - The associated information need only be as simple as a geocode
    - The m-spatial enabled service can do the rest

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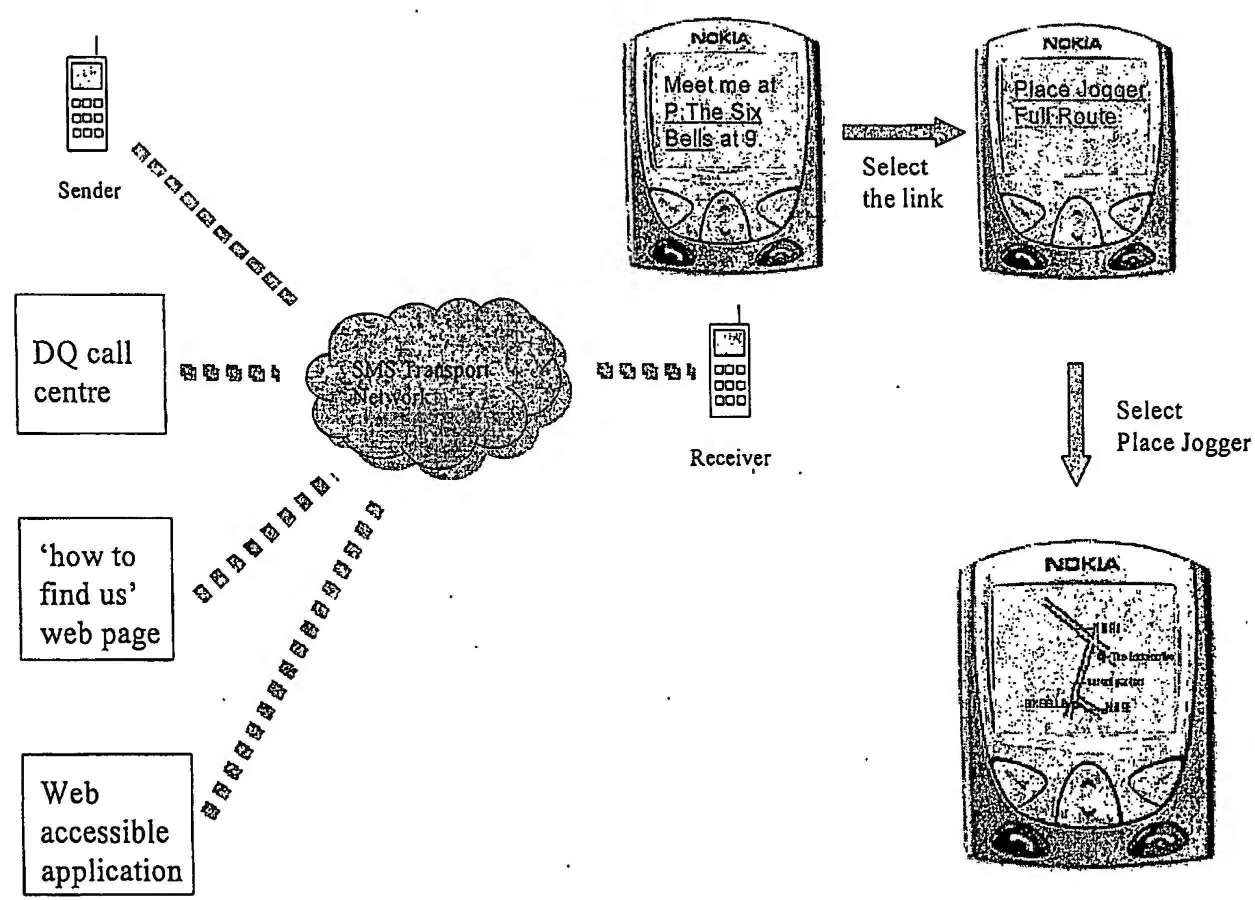
Easing User Access

Location Tag Example



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Easing User Access
Push Services (II)

- Location tags can be complementary to the MyPlaces concept
  - But have advantage of anonymous use
    - No need to pre-register for generation of a MyPlaces list
  - 3rd party applications can deliver the location information more easily
    - E.g. Directory assistance call can deliver SMS with location tag for directory entry included along with the phone number – no need for integration to allow access to MyPlaces lists

Other benefits (I)

- Dynamic creation of sketch maps means that they can be personalised independently of lower level data
  - At the simplest level this means that a tourist guide offered by international operator can have same look and feel in London, Paris and Rome – even if data is from different sources
  - Highlighted POI priority can vary depending on application and subscriber profile
    - E.g. Shopfinder for shoe shop addict might highlight all shoe shops along a route

Other benefits (II)

- Data represented may not necessarily be 'traditional geographic data'
  - E.g. 'StandFinder' application for trade shows
  - E.g. an indication on a route as to the 'safeness' of a specific area

GB0[illegible]00297

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 21 MAY 2003
WIPO PCT

PRIORITY DOCUMENT

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I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

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Patents Form 1/77

Patents Act 1977
(Rule 16)

THE PATENT OFFICE
A
25 NOV 2002
LONDON

The Patent Office

26NOV02 E766135-1 D02000
P01/7700 0.00-0227466.0

1/77

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

25 NOV 2002

The Patent Office
Cardiff Road
Newport
South Wales
NP10 8QQ

1.	Your reference	PDC/DCL/24121 02 GB
2.	Patent application number *(The Patent Office will fill in this part)*	0227466.0
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	m-spatial Limited St John's Innovation Centre Cowley Road Cambridge CB4 0WS
	Patents ADP number *(if you know it)*	8309445001
	If the applicant is a corporate body, give the country/state of its incorporation	UK (28-2-03 All).
4.	Title of the invention	Schematic Generation
5.	Name of your agent *(if you have one)*	
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	MATHYS & SQUIRE 100 Gray's Inn Road London WC1X 8AL United Kingdom
	Patents ADP number *(if you know it)*	1081001

		Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	GB	GB 0201517.0	23/01/02

		Number of earlier application	Date of filing *(day / month / year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application		

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Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
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Signature Mathys & Squire Date

MATHYS & SQUIRE 25 November 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

DR PAUL COZENS 020 7830 0000

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SCHEMATIC GENERATION

The invention relates to a method of and apparatus for generating data representative of a geographical network and a method of providing a graphical schematic of a location. The invention finds particular application in the field of routing services for mobile devices.

Conventional World-Wide Web based routing and guidance services provide information geared to large-screen devices such as computer terminals, but are generally unsuitable for use with small devices such as mobile phones and PDAs.

Mobile devices usually have small screens with limited capacity for representing complex geographical information such as maps.

The invention seeks to address some problems associated with known systems.

Accordingly, a first aspect of the invention provides a method of generating data representative of a geographical network, using a database containing data representative of nodes and edges connected to such nodes, the nodes and edges being representative of the geographical network, and the method comprising the steps of (a) selecting data from the database relating to an extended junction, which junction comprises at least one node and at least one edge, and (b) outputting the selected data.

The terms 'node' and 'edge' as used herein are preferably used in the topological sense, such that, for example, a node may define a point in a network, and an edge may define an interconnection between any two such points. Such an edge may be constrained to a straight line, or may define a more complicated interconnection. In the context of a road network, a 'simple' road junction (where two or more roads meet at a point) could be considered a 'node' and the roads themselves could be considered 'edges'.

The term 'extended junction' as used herein preferably connotes a combination of node(s) and edge(s) that together can be considered to form a single 'higher-level' node and related edge(s). For example, in the context of a road traffic junction, the

many road junctions surrounding a roundabout may be considered as forming a single extended junction (node) with all of the roads feeding into the roundabout as edges connected to it. By contrast, a 'simple junction' preferably connotes an indivisible entity in the network (such as a T-junction in a road network) comprising a single node and connected edges.

By selecting an extended junction, and selecting and outputting data relating to it, the data representative of a geographical network can be generated more efficiently, for example since sufficient information relating to a junction can be provided without the need necessarily to select and output all of the data in the database.

The database is preferably a database of geographical data, for example containing coordinates and interconnection information defining a road network (or alternatively a rail or footpath network, and so on). The database may contain, for example, tables containing node and edge data respectively, and a further table defining the interrelationship between the two.

Preferably the step of selecting data comprises (i) selecting from the database a node which forms part of the extended junction, and (ii) selecting from the database in accordance with predetermined criteria at least one edge which forms part of the extended junction and which is connected to the selected node.

This can further reduce the amount of data which needs to be selected for a particular representation.

The step of selecting data may comprise selecting an edge if the length of the edge is less than a predetermined length. Alternatively or additionally, the step of selecting data may comprise selecting an edge in accordance with a related flag in the database (for example, a flag indicating whether or not the edge is to be considered as significant).

Also, the step of selecting data may comprise selecting an edge in accordance with data in the database which relates the edge with another edge that has already been selected.

The step of selecting data may even comprise selecting an edge if the edge is an element of a road artefact such as a roundabout, dual carriageway or traffic island. The step of selecting data may further comprise analysing the network adjacent to an edge to determine whether the edge is an element of a road artefact.

The step of selecting data preferably further comprises the step of selecting at least one node connected to any of the selected edges. This can again improve the efficiency of the selection of data by ensure that further selected data (such as the above-mentioned node connected to any of the selected edges) has a clear relation to the initially selected node.

Alternatively or additionally, the step of selecting data may further comprise the step of selecting at least one edge connected to but not forming part of the extended junction. This can allow a context to be generated for the extended junction without necessarily requiring the entire data set to be selected.

Preferably the step of outputting the selected data comprises transmitting the selected data to a client device, such as a mobile device (for example a mobile phone or PDA). By transmitting the selected data to the device, rather than for example selecting the data in the device itself, the memory and speed requirements of the client device can be minimised.

Preferably the method further comprises the step of displaying the selected data on a handheld device, preferably in the form of a graphical schematic. Thus, any screen size (and cost) may be kept to a minimum. Alternatively, text may be used either to render a simple schematic, or to provide a descriptive summary of the data, with a potential benefit in terms of the reduced amount of data which may need to be output.

Preferably the method further comprises selecting further data relating to a further extended junction by selecting a further node in the database, and identifying one or more further edges connected to the selected node and meeting the same or further predetermined criteria, and further outputting the further data relating to the further

extended junction. This can usefully extend the range of the data whilst avoiding a potentially wasteful generation of data less relevant to the initially selected node.

In a further aspect of the invention there is provided a method of processing data representative of a geographical network, which network is formed from nodes connected by edges, the method comprising selecting an edge, analysing the portion of the network adjacent to the selected edge to determine whether the edge is an element of an artefact; and processing the selected edge in dependence on the result of the analysis.

The term 'artefact' as used herein preferably connotes a network component which comprises at least one node and at least one edge and whose presence is incidental to the overall structure and/or purpose of the network, and moreover may be the cause of additional complication to the network. For example, in the context of a road network, a traffic island can be considered an 'artefact', since it is not required for the purpose of efficient navigation from one location to another, and creates additional road junctions (nodes) and connecting roads (edges) in its vicinity.

By such analysis and processing to take into account artefacts in the network, processing time and data size can be prioritised accordingly.

The step of analysis preferably comprises determining whether the configuration of the portion of the network adjacent to the selected edge satisfies predetermined criteria. Where the network is a road network, for example (other otherwise), the step of analysing the network may comprise determining whether the edge forms part of a traffic island.

Preferably the method further comprises processing the set of selected nodes and edges in accordance with a modification algorithm, thereby allowing the data to be further optimised for any particular application. Such a modification algorithm may be written in an interpreted or a compiled language (such as PL/SQL, C++ or Java, for example). The method may further comprise modifying a graphical schematic produced from the data in accordance with a predetermined modification algorithm.

In a related aspect of the invention, there is provided a method of processing data representative of a geographical network, the method comprising the steps of (a) retrieving the data from a database, (b) processing the data in accordance with a modification algorithm, and (c) outputting the processed data.

Preferably the modification algorithm geometrically simplifies the data, potentially reducing data sizes.

Where the data includes a plurality of nodes, the modification algorithm may adjust the relative positions of the nodes. Where the data includes a plurality of edges, the modification algorithm may adjust the relative angles between at least two such edges. The modification algorithm may snap the relative angles of at least two edges to one of a set of preferred angles, and the algorithm may adjust the relative angles of at least two edges to be parallel or anti-parallel.

Furthermore, the modification algorithm preferably includes the steps of (a) identifying preferable alignment relationships between different elements of the data, and (b) adjusting the relative positions of the elements so as to provide an arrangement which best satisfies the identified alignment relationships.

Where the data includes at least one node and at least one edge connected to the node(s) and being representative of at least one junction exit, the modification algorithm may include the steps of identifying at least one edge as a junction exit, identifying preferable alignment relationships between the or each junction exit, and adjusting the relative positions and/or angles of the junction exits so as to provide an arrangement which best satisfies the identified alignment relationships.

The method may further comprise computing a measure of the strength of the alignment relationships in dependence on the similarity of the geometry of the elements to a predetermined relationship, such as a parallel or anti-parallel relationship.

Where the data includes at least one node and at least one edge connected to the node(s), the modification algorithm may preserve anti-parallel relationships between

pairs of edges in preference to parallel relationships between pairs of edges, and/or the modification algorithm may include the steps of identifying one or more of said edges as junction exits, and grouping the junction exits into clumps of junction exits which can be displayed as emanating from the same point.

Also, the modification algorithm may attempt to minimise the numbers of clumps in the graphical schematic.

Additionally, where the data includes at least one node and at least one edge connected to the node(s), the modification algorithm may include the steps of (a) identifying one or more of said edges as junction exits, (b) determining the angle of each of the junction exit(s), and (c) modifying the data in accordance with the angle(s) of the junction exit(s). The junction exit is preferably defined by a series of polyline segments at different angles, and the angle of the junction exit is preferably determined by analysing the polyline segments to determine a representative angle.

The modification algorithm preferably aligns the graphical data with a selected screen geometry.

In a further aspect the invention provides a method of providing a graphical schematic of a location, the method comprising the steps of: (a) selecting one or more of points of interest from a database in accordance with a predetermined selection algorithm, (b) generating a graphical schematic including the selected points of interest, and (c) outputting the graphical schematic generated in step b).

The selection algorithm can enable a relatively 'uncluttered' schematic to be generated, in which only relevant points of interest (herein referred to as POIs) are provided, and other redundant information is omitted.

Preferably the algorithm includes the steps of ranking a plurality of points of interest, and selecting one or more of the points of interest in accordance with their rank. Thus for example the algorithm may select only a predetermined number of points of interest, for instance the ten highest ranked points of interest.

Preferably the algorithm includes the steps of retrieving one or more stored parameters associated with each point of interest, and selecting one or more of the points of interest in accordance with their associated stored parameter(s). Thus for instance the parameter may indicate the category of the POI (for instance the POI may be categorised as a 'Cinema' or a 'House'). In this case the algorithm may only select POIs within a certain category, or may preferentially select POIs within that category.

Preferably the selection algorithm comprises the steps of selecting a location; and selecting one or more points of interest within a predetermined radius of the selected location. Thus the algorithm can limit the field of selection.

In one example the database includes a plurality of nodes and the selection algorithm includes the steps of selecting a node, defining a region surrounding the node, and selecting points of interest within the defined region. Thus the node may represent, for instance, a junction in a road map.

The region may have a complex shape, or the method may, for example, comprise defining a circular region centred on the node.

The selection algorithm may select one or more of points of interest from the database in accordance with the visibility of the points of interest, or in accordance with the time of day.

The method may further comprise storing a list of favourite points of interest associated with a particular user, the selection algorithm then preferentially selecting points of interest stored in the list.

The method may further comprise the steps of (a) calculating a direction, and (b) outputting data which indicates the direction calculated in step a). In contrast with a conventional 'map', which may include an arrow indicating the direction north, this aspect of the invention enables any resulting graphic schematic to be 'customised' by indicating any desired direction - for instance to indicate the direction in which a user should move in order to proceed to a desired destination.

This important feature is also provided independently. Accordingly, in a related aspect of the invention there is provided a method of providing a graphical schematic of a location, the method comprising the steps of (a) calculating a direction, (b) generating a graphic schematic including information which indicates the direction calculated in step a), and (c) outputting the graphical route schematic.

The information may be presented in a variety of ways. For example the schematic may be coloured red in the desired direction, and blue away from the desired direction, with gradations of colouring in-between. Preferably the information is provided in the form of a marker such as an arrow.

Typically the graphical schematic includes a junction including a incoming road segment taken into the junction and a outgoing road segment taken out of the junction, and the method includes the step of determining the angle between the incoming and outgoing road segments and selecting the information in step b) in accordance with the angle. For instance the number of arrows included in the graphical schematic may vary in accordance with the angle.

The method may further comprise the steps of determining the current position of the moon or sun, and outputting data which indicates the current position of the moon or sun as determined in the previous step.

This aspect can enable a user of the data to orient themselves more easily by noting the current position of the moon or sun, and correlating this with the information provided in any resulting schematic.

In a further aspect the invention provides a method of providing a graphical schematic of a location, the method comprising the steps of: (a) determining the current position of the moon or sun, (b) generating a graphical schematic of the location, the schematic including information which indicates the current position of the moon or sun determined in step a), and (c) outputting the schematic generated in step b).

The information may be provided in a variety of ways. For instance the schematic may be coloured more brightly in the direction of the moon or sun. Alternatively the

information may comprise a marker. In one example the position of the marker within the schematic is dependent on the current position of the moon or sun. In another example the marker may comprise a shadow image, the configuration of the shadow image being dependent on the current position of the moon or sun.

The method may further comprise the steps of (a) receiving configuration data, and (b) generating the graphical schematic in accordance with the configuration data received in step a). This can enable a graphic schematic to be 'customised' in any desired manner, for instance to adapt to different device properties (such as screen size or resolution) or user preferences.

In a further aspect the invention provides a method of providing graphical schematic data, the method comprising the steps of (a) receiving configuration data, (b) generating a graphical schematic in accordance with the configuration data received in step a), and (c) outputting the graphical schematic generated in step b).

The method may further comprise (a) selecting a network element from a database, (b) selecting a point of interest from a database in accordance with a predetermined selection algorithm, (c) determining a geometrical relationship between the network element selected in step a) and the point of interest selected in step b), (d) generating an abstract representation of the point of interest in accordance with the geometrical relationship determined in step c), (e) generating a graphical schematic including the set of network elements selected in step a) and the abstract representation of the point of interest generated in step d), (f) outputting the graphical schematic.

In a further aspect the invention provides a method of providing a graphical schematic of a location, the method comprising the steps of (a) selecting a network element from a database, (b) selecting a point of interest from a database in accordance with a predetermined selection algorithm, (c) determining a geometrical relationship between the network element selected in step a) and the point of interest selected in step b), (d) generating an abstract representation of the point of interest in accordance with the geometrical relationship determined in step c), (e) generating a graphical schematic including the set of network elements selected in step a) and the abstract

representation of the point of interest generated in step d), and (f) outputting the graphical schematic.

This aspect generates an abstract representation of a point of interest (POI) based on the geometrical relationship of the POI with a network element (such as an edge or node). This enables the network element to be manipulated (for instance translated or rotated) whilst maintaining a consistent display of the POI relative to the network element. The geometrical relationship is generally some relative relationship such as apparent size, visibility or closeness. Other non-relative properties of the POI (such as actual size, shape etc) can be disregarded.

In particular, the geometrical relationship may relate to the visibility of the point of interest from the edge, to the apparent size of the point of interest from the edge, or to the distance of the point of interest from the edge. The abstract representation of the point of interest may comprise an abstract frontage of the point of interest, directed towards the edge.

In a further aspect the invention provides a method of providing a graphical schematic of a location bounded by a defined geographical area, the method comprising the steps of (a) selecting one or more of points of interest falling outside the defined geographical area from the database, (b) generating a graphical schematic of the defined geographical area, the graphical schematic including an indication of the direction of the point(s) of interest falling outside the defined geographical area; and (c) outputting the graphical schematic generated in step b).

This aspect of the invention enables further information to be provided – for instance if the defined geographical area contains no POIs, or if the selected POI(s) are of particular importance - for instance the direction of a highly visible landmark (such as the Eiffel Tower in Paris) may be indicated, despite the fact that it lies outside the area.

The graphical schematic may include first source data from a first source and second source data from a second source.

In a further aspect the invention provides a method of providing a graphical schematic, the method comprising the steps of obtaining first source data from a first data source, obtaining second source data from a second data source, generating a graphical schematic including said first source data and said second source data, and outputting said graphical schematic.

This aspect can 'merge' or 'conflate' data from different sources in order to generate the schematic.

Preferably the method includes the steps of identifying a first feature in the first data source, identifying a second feature in the second data source, determining whether the second feature overlaps with the first feature, and associating the second feature with the first feature if the second feature overlaps with the first feature. This can enable the data from the two sources to be merged smoothly. Thus for example the first feature may be a building, and the second feature may be a name associated with that building.

In one example the method further comprises identifying a second set of extended junction elements by selecting a node from the data source, and identifying one or more internal edges which connect with the selected node and meet predetermined criteria; wherein the output graphical schematic output includes a first extended junction comprising the first set of extended junction elements, and a second extended junction comprising the first set of extended junction elements.

The first and second extended junctions may be joined for example by a continuous or broken line.

A further aspect of the invention provides a method of processing graphical data, the method comprising selecting an edge which forms part of a network of nodes connected by edges; analysing the network adjacent to the selected edge to determine whether the edge is an element of a road artefact; and processing the selected edge in accordance with the analysis.

This method enables a certain type of road artefact (such as a traffic island, roundabout or dual carriageway) to be identified and processed accordingly. Previously this has only been possible by labelling the artefact in the source data.

A further aspect of the invention provides a method of providing a graphical schematic of a location, the method comprising the steps of:

retrieving graphical data from a database;

generating a schematic by modifying the graphical data in accordance with a predetermined modification algorithm; and

outputting the schematic generated in step b).

This aspect enables a schematic to be customised for instance by aligning the graphical data with a selected screen geometry. Alternatively the schematic may be simplified for instance by straightening lines. Alternatively the 'look and feel' of the schematic may be customised, for instance by shading areas according to crime statistics.

The modification algorithm may simplify the graphical data for example by adjusting the relative positions of nodes or relative angles of edges in the graphical data.

An advantage of this aspect is that a variety of different schematics can be generated from a common set of source data. Also, the format and/or content of the schematics can be customised for a particular user or output device.

Typically the modification algorithm includes the steps of identifying one or more edges as junction exits; identifying alignment relationships between the junction exits; and adjusting the relative positions and/or angles of the junction exits so as to provide an arrangement which best satisfies the identified alignment relationships. Thus for example the algorithm may preserve particularly strong relationships, such as anti-parallel or parallel alignment relationships.

The modification algorithm may also include the steps of identifying one or more edges as junction exits; and grouping the junction exits into clumps of junction exits

which can be displayed as emanating from the same point. The numbers of clumps can then be minimised so as to simplify the schematic.

The modification algorithm may align the graphical data with a selected screen geometry.

In a further aspect of the invention there is provided apparatus for generating data representative of a geographical network, using a database containing data representative of nodes and edges connected to such nodes, the nodes and edges being representative of the geographical network, and the apparatus comprising (a) means (such as a processor and associated memory) for selecting data from the database relating to an extended junction, which junction comprises at least one node and at least one edge, and (b) means (such as an output) for outputting the selected data.

There is also provided in another aspect of the invention apparatus for processing data representative of a geographical network, the apparatus comprising (a) means (such as a processor and associated memory) for retrieving the data from a database, (b) means (such as a processor) for processing the data in accordance with a modification algorithm, and (c) means (such as an output) for outputting the processed data.

In a further aspect there is provided apparatus for providing a graphical schematic of a location, the apparatus comprising (a) means (such as a processor and associated memory) for selecting one or more of points of interest from a database in accordance with a predetermined selection algorithm, (b) means (such as the same or a further processor and associated memory) for generating a graphical schematic including the selected points of interest; and (c) means (such as an output) for outputting the graphical schematic.

In a further aspect the invention provides apparatus including features for performing the method steps described above in any aspect of the invention. Typically the apparatus is in the form of an appropriately programmed computer. In a preferred example the apparatus is in the form a central server remotely located from a user, where the user may be a Location Based Service (LBS) and/or a mobile client device. The central server is typically configured to generate and output schematics to the

LBS and/or mobile client device. The mobile device (typically a hand-held device) is appropriately configured to receive and present schematics (typically in graphical form) to a user.

The disclosed methods of and apparatuses for providing graphical schematics of locations may be freely modified to generate data representative of geographical networks and *vice versa.*

The invention also provides a computer program and a computer program product for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein, and a computer readable medium having stored thereon a program for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein.

The invention also provides a signal embodying a computer program for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein, a method of transmitting such a signal, and a computer product having an operating system which supports a computer program for carrying out any of the methods described herein and/or for embodying any of the apparatus features described herein.

Features implemented in hardware may generally be implemented in software, and vice versa. Any references to software and hardware features herein should be construed accordingly.

Any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, method aspects may be applied to apparatus aspects, and vice versa.

Preferred features of the present invention will now be described, purely by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic drawing of the basic system hardware;
Figure 2 is a schematic drawing of the software architecture;

Figure 3 is a schematic drawing of a location and guidance service;

Figure 4 is a view of a network;

Figure 5 illustrates a data set resulting from a growing algorithm performed on the network of Figure 4;

Figure 6 illustrates segmentation of the data set of Figure 5;

Figure 7 is a view of a set of route edges associated with a route;

Figure 8 shows a geometrically simplified version of Figure 7, including four sectors associated with one of the junctions;

Figures 9 to 12 are exemplary schematics as generated by one embodiment of a schematic generator;

Figures 13 and 14 are exemplary schematics as generated by another embodiment of a schematic generator;

Figure 15 shows a map of a road network;

Figures 16A, 16B and 16C show examples of abstract representations of the road network of Figure 15;

Figure 17 shows road network data representing the road network;

Figures 18a, 18b and 18c are schematics of different routing subsystems;

Figure 19 illustrates the typical road network configuration of a traffic island;

Figures 20A, 20B, and 20C show a map of a different road network, road network data for that network, and a simplified representation of that network respectively;

Figure 21 illustrates the identification of an extended junction from the road network of Figure 15;

Figure 22 illustrates the identification of clumps of exits;

Figures 23A, 23B and 23C illustrate the simplification of a network comprising two edges having a near-parallel relationship;

Figures 24A, 24B and 24C illustrate the simplification of a network comprising two edges having a near anti-parallel relationship;

Figure 25 shows an abstract representation of the road network of Figure 15 as generated by the schematic generator;

Figure 26 shows a corresponding schematic generated by the schematic generator;

Figures 27A, 27B, 28A, 28B and 28C illustrate methods of displaying more than one simplified junction in a single schematic; and

Figures 29A, 29B, 30A and 30B illustrate a method of providing an abstract representation of a point of interest in a schematic.

1. Overview

1.1 Architecture

A basic system hardware architecture is shown in Figure 1. A location/guidance server 1 is connected to a database 2 and communication network 3. The communication network 3 communicates with a mobile device 4 via a wireless link. A Location Based Service (LBS) server 10 is also connected to the communication network 3.

1.1.1 Mobile Device

Mobile device 4 is typically a hand-held device such a mobile phone or personal digital assistant (PDA). The mobile device 4 may have a significantly smaller screen, lower data transfer rate and more limited user interface than is found in equivalent browser/hardware arrangements for the fixed Internet. Two different classes of mobile device are considered here (though in other embodiments, different kinds of devices may be used): small devices and medium devices.

Small and medium devices differ in certain characteristics, including screen resolutions, colour / monochrome displays and user interaction methods. For example, smaller devices such as Wireless Application Protocol (WAP)-enabled mobile telephones (one example being the Siemens S45 mobile phone) would typically have small, monochrome displays, using standard mobile telephone keys and WAP menus for user interaction. Medium size devices may have slightly larger screen resolutions (typically no less than 120 x 120 pixels) and may have colour displays. An example of such a device is the Trium Eclipse mobile phone. The information generated for small and medium devices is generally different and takes into account the different characteristics of the devices.

The approach taken for medium size devices is also applicable to larger devices such as the Compaq Ipaq or Nokia 9210, which typically have larger resolution colour displays and use a point-and-click interface, which may be operated using a stylus. Therefore, "medium devices" shall be taken to include such devices. In fact, techniques described for small and medium devices may be applied to devices of any size. Furthermore, according to user preference, schematics described below for medium devices can be used on small devices, particularly if limited to a view of a single junction.

The mobile device 4 may also be a General Packet Radio Service (GPRS) device.

In some embodiments, certain aspects of the routing service may be accomplished by executing software on the mobile device. For example, the mobile device may comprise a Java virtual machine or a browser capable of executing scripts in languages such as JavaScript.

1.1.2 Server

The location/guidance server 1 comprises software modules for location identification and for the generation of routing information such as route schematics as well as interfaces to users of the location/guidance server and to database 2.

Schematics

The information provided by the server 1 is generally in the form of *schematics*. In some cases the schematics may be non-graphical: for instance in the form of textual or voice data. However in most cases the schematics include graphical information in the form of simplified maps, and are derived from conventional mapping and geographical data. Graphical schematics may be in formats including bitmap, Joint Photographic Experts Group (JPEG), Graphic Interchange Format (GIF), Portable Network Graphics (PNG) or a vector graphics format. Schematics may be transmitted to the mobile device by standard protocols such as WAP or Hyper Text Transfer Protocol (HTTP), or by a proprietary protocol.

The schematics include only such information as is useful and necessary for a routing task, or other task. For example, schematics typically include representations of road layouts along with context information, such as prominent buildings or landmarks. Context information of this kind will be referred to as *Points Of Interest*, or *POIs* in abbreviation.

Schematics are commonly labelled with textual information to help the user recognise the various features.

Routing Schematic Types

Various types of schematic are available, each with a specific role in the routing / guidance process. There are three major types of schematics: orientation schematics, location schematics and routing schematics.

Orientation schematics assist users to find their current location before following a route. Location schematics are similar to orientation schematics but are not related to a route; they simply provide an overview of a geographical area.

Routing schematics indicate the correct route to the user using symbols such as arrows or by highlighting the required roads. Routing schematics can be further classified as junction and non-junction schematics. Junction schematics indicate how a user should proceed at a junction of two or more roads. Non-junction schematics illustrate landmarks along sections of the route that do not contain major junctions, to allow the users to gauge their progress along the route.

Routing schematics typically represent part of a route; but overview schematics may be provided which describe a route in its entirety.

The nature of the routing schematics that are generated is in part dependent upon the functionality of the mobile device 4. In general, more detailed routing information can be displayed on large and medium mobile devices than on small mobile devices.

Instead of presenting the user with a graphic schematic, the device may present information in the form of text only, and/or as a synthesised voice.

The routing service generates the most appropriate form of schematic based on knowledge of the mobile device, which may be stored in a database of user information or may be transmitted by the device with each routing request or at the start of each routing session.

Small Screen Routing Schematics

For devices with small screens, the routing schematics are typically:

- *Junction schematics:* at junctions, either a detailed, accurate view or a simplified abstract representation of the junction, along with arrows to indicate movement through the junction and points of interest to help the user work out where he is.
- *Non-junction schematics*: between junctions, a schematic of simplified road layout and key points of interest.

Depending on requirements, non-junction schematics may be omitted, and only junction schematics displayed.

Medium Screen Routing Schematics

For devices with medium screens, the routing schematics are typically:

- Consecutive schematics of sections of the route. The user steps through these as he progresses down the route.
- Each display covers multiple junctions, with routes indicated through and between each.
- Selected points of interest (landmarks, buildings, street furniture) around and between junctions are displayed.
- Most detail is displayed at the junctions. The number of junctions is generally two, but may vary.

Large Screen Routing Schematics

Like the medium screen equivalents, here more than one junction is typically shown per screen.

1.1.3 LBS

A Location Based Service (LBS) – also known as a Location Based Application or Location Enabled Application - is run on a second server 10 which is also connected to the communication network 3. The LBS is an application which uses the location/guidance services of server 1 as part of a larger application. Many examples of such applications may be imagined – one such example might be a restaurant guide which provides a user with information regarding a restaurant close to his present location, including reviews of and directions to the restaurant.

Although in a preferred embodiment, services are offered for use by LBSs, in some embodiments location/guidance server 1 may provide services, for example a complete location and routing service, directly to the mobile device via communication network 3.

1.1.4 Database

Database 2 contains geographical information used by location/guidance server 1 in the identification of locations and generation of routing information. The geographical information includes information on roads, road names and classifications, buildings and building classifications, business names and business classifications, full address data and other geographical and mapping features. In some embodiments, database 2 comprises a single homogeneous database. In the preferred embodiment, database 2 comprises several heterogeneous data sources, such as databases and files.

All the data used by the system is commercially available. There are numerous alternative sources of data in the UK, and equivalents (with different degrees of

comprehensiveness and accuracy) in other countries. For example, the following different classes of data may be used for the UK:

- Large scale cartographic data (for example Ordnance Survey MasterMap). This includes building outlines (used, for example in POI calculations), and may also be used to locate features such as rivers and parkland to be represented on schematics. As will be described later, schematics typically provide junction views which are represented schematically or by displaying a small but accurately drawn extract from the cartographic data covering the junction of interest (i.e. a small map), with the outlines of POI buildings highlighted and labelled.
- Road network data (for example TeleAtlas), which includes connections between roads (e.g. at junctions), absence of connections between roads that cross but do not connect (e.g. flyovers), classification of roads (Motorway, A, B etc), some pedestrian paths/walkways, and identification of separate road geometries that make up the same complex road layout (e.g. junctions, roundabouts, dual carriageways). Similar data is also available from NavTech and Ordnance Survey.
- POI data (for example E-street and Ordnance Survey AddressPoint), that consists of points with attributes and classifications identifying the nature and specific details of potentially interesting things in the real world (shops, restaurants, landmarks etc). The AddressPoint data has a point for every address in the country, but includes only 'vanilla' information like name (in some cases, particularly businesses), number and postcode. The E-street data identifies a smaller number of points, but with much better classification and information about what and who they represent. POI data is used in the POI selection step.

There are other suppliers of data that may be used by the system.

1.1.5 Software Structure

The location/guidance server 1, in combination with database 2, provides a locating, routing and guidance 'web service' accessible through Internet-like protocols to the LBS running on server 10. The web service provides an Application Program Interface (API) to LBS developers.

The structure of the software that provides this web service will now be described in more detail with reference to Figure 2. The location/guidance technology includes a number of layers, including:

- Web service interface 40 provides the API and infrastructure to allow the LBS to access the location/guidance technology and to allow the location/guidance technology to manage multiple users for the LBS.
- The service modules 42 are software modules which provide various aspects of the location/guidance services, including identifying locations and generating schematics.
- The feature model 44 is a data model which supports the service modules.
- The feature store 46 is a mechanism for overall management of data, providing a single common interface to all data regardless of the source from which it is drawn.
- The connectors 48 are interface modules which allow data stored on disk in different formats to be accessed efficiently and presented to the higher parts of the system through a common interface at the feature store level.
- Data sources 50 are files and/or databases on disk, either in third party formats where databases have been supplied by third parties, or in proprietary formats.

For example, referring back to Figure 1, following interaction between LBS server 10 and mobile device 4, LBS server 10 makes a routing request to guidance server 1. Referring now to Figure 2, this request is received by web service interface 40, which invokes the appropriate one (or possibly several) of service modules 42. The invoked module then requests any required data from feature store 46 using feature model 44.

Feature store 46 identifies the source(s) of the required data, and fetches the data from one or more of data sources 50 using the appropriate connector(s) 48.

1.1.6 Indexing Method

A method of indexing geographical features will now be described. The method is used by the system to find features in a given area.

The indexing method splits a large map (for instance a map of the UK) into a grid of patches or tiles. This grid is not necessarily uniform as different tiles may be of different sizes. Each tile includes a list of features located in the geographical area represented by the tile, including roads or POIs such as transport nexuses or shops. Generally, large tiles are used to represent geographical areas with a low density of features, while areas containing a high density of features (for example, urban areas) are represented by small tiles. Since the tiles are of different sizes, it is not possible to directly locate the correct tile solely using known coordinates. Therefore, several layers of tiles at successively lower resolutions are provided, such that in the highest layer a single tile covers a large area and lists all the tiles in the next layer which are enclosed within the area of the higher layer tile.

The indexing algorithm identifies the correct tile by searching downwards through the hierarchy of tiles. In this way, the algorithm searches until it locates the final (highest resolution) tile, which covers an actual geographical area, and lists the features within that area.

The advantage of this indexing scheme is that it is easy to quickly access all the information relating to a specific geographical area. If a single tile does not cover the area of interest, several surrounding tiles are examined. In some embodiments, separate servers each cache information covering a certain area.

1.2 Service Overview

Generally speaking, the location/guidance server 1 provides the following services which are implemented by service modules 42:

- Identifying a mobile device user's present location
- Identifying a user's desired destination
- Generating routing information for routing the user from his present location to his desired destination.

Individual Location Based Services may use only aspects of the services provided. For example, LBS server 10 may request routing information only, providing starting and finishing locations as parameters of the request.

Alternatively, these services may be combined to provide a complete location and guidance service incorporating the three steps of identifying the device's present location, identifying a desired location and providing routing information between the two.

1.3 Example Routing Service

An example of a location and guidance service will now be described in overview with reference to Figure 3.

Routing and location-related queries are received from mobile device 4 via communication network 3 by routing application 100, which manages the interaction with the user of the routing service. A user interface is provided as part of the routing application, for example in the form of a Wireless Application Protocol (WAP) site. The user interface allows the user to perform tasks such as entering information relating to route start and end points and requesting routing information.

Start/end point module 110 provides services to the routing application, including determining and/or selecting start and end points for a routing request and for determining the location of a mobile device. It uses network fix module 112 to obtain location information relating to the location of mobile device 4 from communications network 3 if required.

Routing application 100 generates routing requests based on the user queries and passes these to routing subsystem 200. These may, for example, comprise two or more geographical coordinates defining a route for which routing information is to be generated.

Routing subsystem 200 comprises router 210, POI selector 220, route segmenter 230 and schematic generator 240.

Router 210 identifies a route based on the received routing request. POI selector 220 selects relevant points of interest along the route to assist the user in following the route. Route segmenter 230 segments the route into separately displayable route sections. Schematic generator 240 generates route schematics of route segments, and may generate other types of schematics, such as route overview schematics, location schematics and orientation schematics.

Start/end point module 110 and routing subsystem 200 communicate with geographical database 2 to access geographical information.

A user profile manager 120 maintains information relating to registered users of the system, which is held in a user profile database (not shown). In some embodiments, some or all of the user-related information is instead or additionally held locally on the mobile device.

User profiles may comprise a variety of types of user information, including:

- Identifying information (for example a user's mobile telephone number and mobile device type)
- Usage histories (for example, recently / frequently visited places)
- Preferences (for example, preferred start / end points, preferred POI types, software configuration preferences). In particular, a list of favourite, commonly used locations is held in the user profile. This is referred to as a "MyPlaces" list.

Users may communicate with the user profile manager using their mobile device 4 (for example, via a WAP site) or via some other device such as a computer terminal 5 connected to the communication network 3 (for example, via a World Wide Web site), and may update their user profiles according to their requirements.

Routing application 100 and routing subsystem 200 customise the routing service and the routing information generated based on information stored in user profiles, which they access via the user profile manager. Furthermore, routing application 100 may update user profiles via the user profile manager in response to user interaction. As an example, routing application 100 may allow a user to add locations to a list of preferred locations held in his user profile, and may automatically record history information relating to a user's routing queries in the user profile.

2. Routing subsystem overview

Returning to Figure 3, the routing application 100 generates routing requests in response to interaction with a user during which the start and end points of the required route are identified. This routing request typically comprises the coordinates of the start and end points identified. The routing request is passed to the routing subsystem 200.

In response to such a routing request, the routing subsystem carries out the following tasks:

- the required route is identified by router 210
- POIs along the route are selected by POI selector 220
- the route is segmented by route segmenter 230
- the first of the sequence of route schematics is generated by schematic generator 240

The generated schematic is then passed back to the routing application for display to the user. When the user requests the next route schematic, the routing application sends a route update request to the routing subsystem, in response to which the next routing schematic is generated by the schematic generator.

3 Router

The router will now be described.

Geographical data sources such as TeleAtlas provide road information as a network of interconnected nodes, where edges represent road segments and nodes represent junctions where road segments meet. As well as representing roads, the edges may also represent footpaths or any other entities accessible to pedestrians. The desired route is found by identifying a path of connected nodes through the network from the starting location to the finish location.

The coordinates associated with the start and end locations specified in the routing request may not lie exactly on the road network nodes or road segments. For example, the data supplier may specify the location of a building by providing the coordinates of an arbitrary location within said building. In these cases, the corresponding network node is calculated by searching for the nearest road segment to the start or end coordinate. If an address is associated with the start or end coordinate, then only those road segments matching this address are considered during this search. Restricting the search in this way increases the likelihood of finding a network point near to the relevant entrance to the building.

3.1. Route Selection Based on Shortest Route

The route selected may be the shortest route, either in terms of distance or journey time. Where the routing information is aimed at a pedestrian user whose speed is taken to be roughly constant regardless of the type of road (or footpath) used, the shortest distance and shortest travel time paths are likely to be the same. Therefore, given that distance information is readily available from the database, the shortest path is calculated in terms of distance.

This is achieved using conventional path finding algorithms. For example, from the starting point, the router explores all possible edges to get to the next node on each edge. It stores each of these as a possible partial route. As each new node reached, it

explores all possible edges to new nodes, and again stores each as a set of possible partial routes. It does this until the destination is reached. In an enhanced, more efficient version, each possible partial route is assigned an estimated total cost (e.g. current distance, plus the straight line distance to the target from the current end of the route). At any stage, only the partial route with the lowest estimated total cost is explored. Once one route has reached the destination, only partial routes with estimated costs lower than the actual cost of that route are explored further. This results in a faster determination of the lowest cost route. The exact mechanism for estimating the total minimum cost of a route may vary if a cost other than simple distance is required.

3.2 Route Selection Based on User Profile

Alternatively, the route selection may be based on a user profile, or stored on the mobile device 4. For instance the user profile may specify that the route selection routine should seek to identify the safest route (for example, by not selecting footpaths or minor roads as part of the road).

3.3 Route Selection Based on User Input

Finally, the user may be able to select a particular route or constrain the route selected by specifying waypoints or other constraints, which are provided as parameters of the routing request.

3.3 Building network structure around route

After a route has been identified, a data set containing extra network structure is built around this route.

Consider, as an example, the route through a network shown in Figure 4.

The route itself is labelled 'A', roads labelled 'B' are major roads, other roads are minor roads. This type of classification is usually present in cartographical data

(standard data from TeleAtlas may be used; or similar datasets are also available from NavTech and Ordnance Survey).

Starting from the route 'A', a data set of extra network structure is grown out from the route a set distance (currently 80m). The growing algorithm follows those roads which are of equal or greater importance to the original route and adds portions of them to the data set, classifying them as 'route structure'. Roads which are of lesser importance are added to the data set as spurs (road stubs). If a complete road is included as 'route structure' but is less than the set distance, then the roads that it connects with are also analysed.

Junctions where the original route meets a road of equal or greater importance are classified as 'significant'. Other junctions ('insignificant' junctions) would typically correspond to spurs.

The data set resulting from the growing algorithm on the example network is shown in Figure 5.

Those elements corresponding to the original route are labelled 'A', those labelled as 'route structure' 'B'. Elements labelled 'C' are 'spurs'. Significant junctions are marked with circles.

Once the route has been generated, the POI selector identifies points of interest along the route for possible inclusion in routing schematics. The route is then supplied to the segmenter, which, in response to route update requests received from the user via the routing application, makes successive calls to the schematic generator to generate schematics for individual segments of the route.

During the process of routing the user along the route by presenting this sequence of schematics, the routing application may send a modified routing request. This may happen if, for example, the user becomes lost whilst following the route. In this case the existing route is discarded and a new route calculated based on the modified request.

4. POI selector

Once the route has been calculated, points of interest (POIs) such as prominent buildings are identified along the route for later display to the user. These help the user find his way along the suggested route. Various methods of selecting POIs are described below.

4.1 Sector Ranking

POIs near junctions are given particular importance as they can be referred to by the user when deciding which of several roads to take. To identify such POIs, a set of sectors is constructed around each junction. An example of this is given in Figure 8.

Consider a route passing along network elements 20,23 and 24. The junction comprising network elements 23-26 is divided into four sectors, each sector being bounded on two sides by an adjacent pair of roads and on the third side by a curved search radius 30-33 at a predetermined distance from the junction.

Each sector is assigned a sector ranking (a value between zero and one), giving preference to sectors that are adjacent to the route. Thus, in Figure 8, sector 30 is bounded on two sides by network elements forming part of the route and therefore has a high ranking; sectors 31 and 33 are bounded on one side only and therefore have a medium ranking; and sector 32 is not bounded on any side and therefore has a low ranking.

4.2 POI Ranking

Each sector 30-33 is then searched for POIs and a ranking determined for the POIs found. A POI is a candidate if its geometry is contained by, or intersects with, the sector. The server 1 may search for POIs from a number of different data sources 50 (shown in Figure 2). For instance, one of the data sources 50 may be the Ordnance Survey dataset known as MasterMap, which includes objects with a Polygon geometry property representing buildings. Another data source 50 may be the Ordnance Survey dataset known as AddressPoint that includes objects with a Point

geometry property as well as address information for all postal destinations in the UK. The AddressPoint points lie inside the MasterMap Polygons, and can be used to give an address to a building. Another data source 50 may be the dataset provided by E-Street, which provides information on businesses, represented as single points with coordinates.

The ranking of each POI is calculated by adding together a number of contributions:

p1*significanceFactor +
p2*onRouteFactor +
p3*labelFactor +
p4*distanceFactor +
p5*sectorRanking

The various factors have a range of zero to one inclusive, and the parameters (p1,p2,p3,p4,p5) are provided as input to the POI selection algorithm.

The significanceFactor indicates how significant the POI is based on what type of POI it is. For example a POI representing a cinema may be considered more significant than a POI representing a house. The mapping of POI type onto a significance band (typically no more than a dozen) is defined based on the types available. This mapping may be different depending on a user profile. For example pubs or bars may appear higher in the ranking for men than they do for women. In addition the significanceFactor includes a component that ranks larger POIs as more significant than smaller ones (this is applicable when the POI has a polygon geometry). This is calculated using the function described below that takes the square-root of polygon area as input and then divides it by the number of bands. The square-root is used since this provides a better estimate of how much of the POI faces the street.

The onRouteFactor returns a value between zero and one depending on how close the POI is to being 'on route'. If the address for the POI indicates that it is on the route, then it is assumed to be on route. Otherwise the nearest distance to the POI from the route is calculated; if this is below a threshold then the POI is assumed to be on route.

The labelFactor returns a value between zero and one depending on how much space the POI will require to label it in an image.

The distanceFactor returns a value between zero and one depending on how far the POI is from the junction/position being identified. This makes use of the function described below. The distance supplied to the function is the nearest distance between the POI geometry and the junction/position being identified.

The calculation of these factors makes use of a function that maps a value x onto a value in the range zero to one. This has the form

$$1.0 / (1.0 + \exp((x - x0) / xk))$$

Typical values for the constants used in the POI ranking are given below, although it should be noted that an important feature of the system is the ability to change these values easily to tune the system for different types of data (for example, in different countries):

- $p1 = 3.0$
- $p2 = 2.0$
- $p3 = 1.0$
- $p4 = 1.5$
- $p5 = 1.2$
- $x0 = 10.0$ and $xk = 10.0$ for areas in significance
- $x0 = 15.0$ and $xk = 15.0$ for distance from junctions
- Label factor is 0.0 if label length is < 15, and 1.0 otherwise.

4.2.1 Ranking based on user information

The POI ranking scheme described above may be augmented so that the POI selector makes use of information specific to the user to provide better-tailored routing information. For example:

- Because the instruction is generated in near real-time the POI selector may use information about the current time and the location of the user when selection POIs. For example, the time of day may be compared to opening times of businesses, outlets or similar POIs, to help determine what might represent a suitable point of interest. For example, shops could be given higher priority for selection as a POI during times when they are open.
- The POI selector may use locations from the user's personalised list of locations stored in his user profile (for example in a MyPlaces list), especially those that have been used frequently as a start point or end point of a route, as points of interest. Such points of interest can be given high priority to ensure that they are labelled and shown.

4.2.2 Selection of POIs based on POI Visibility

The POI ranking scheme described above may be further adapted to select POIs based on the visibility of the POI. The visibility of the POI is determined using the following steps:

- The POI is associated with a building from the cartographical data (such as that provided by MasterMap) and the nearest edge of the building to a road segment of the route is determined. If the address of the POI is directly on the route, that is to say the address matches, or partially matches, the road name of the road segment then the POI is deemed as visible.

- Alternatively, if there is no address or the address does not match the route then the POI selector also checks if the building lies within a small distance tolerance of the route, in which case the POI is also deemed as visible. This allows, for example, a POI/building that is just off a corner of the route to be still included as a POI candidate, even though the postal address indicates that it does not lie on the route..

- For POIs/buildings that are not very close to the route but have an address on the route the system performs a line of sight calculation to determine whether a given building or other structure is visible from a junction, or other point on the route. This prevents showing a POI that is actually hidden behind another building. For example, if the POI is a statue that is located within a building, then it is clearly not visible and hence is not considered as a POI candidate.

Shops, cinemas or other businesses that are part of well-known chains are given a higher priority for selection as POIs. A fixed list of chains is used for this purpose, listing relevant store names against which the business name of the POI in question is compared.

4.3 POI data access

In general, the geometry of a POI may be represented by a Point, Polyline or Polygon in the MasterMap data source. Other information relating to the same POI may be contained in other data sources such as the AddressPoint or E-Street datasets. Such information is associated with a geographical coordinate, but not a building outline.

The POIs from the different sources are represented in the feature store as POIContent objects, providing uniform access to POI information from separate data sources.

In some circumstances the POI in question may only have a Polygon geometry property within the sector being searched for points of interest. In such circumstances, a spatial search is carried out within the entire POI geometry to locate POIContent objects. The properties of these objects are then used as additional properties of the POI.

For example, a large building (such as a hospital) may be represented by a large polygon in the MasterMap dataset. This polygon may partially overlap with one of the sectors 30-33 - for instance, only a corner of the building may be within a sector, with the rest of the building lying outside the sector. Therefore the building itself will

be identified as a POI within the applicable sector. A POI within the building, for instance contained in the AddressPoint or E-Street dataset may fall outside the sector.

Therefore the POI selector searches the entire building for POIContent objects and treats them as additional properties of the building.

The POIContent objects themselves are not generally treated as POIs. This avoids the possibility of confusion between the POIs (in this case, the building outline polygons) and the objects spatially located within them that carry the other information about the POIs.

In some embodiments, POIContent objects are ignored when searching for POIs – they will only be reached, if needed, via the POIs. In other embodiments, however, POIContent objects not contained by a building (or similar polygon) are treated in their own right as POIs.

4.3.1 Data Merging

The system addresses various problems associated with merging data from different data sources. These problems largely relate to the data being held in different formats, or data from different sources having different names/identifiers for identifying features (or properties of features) of the same type. This is tackled by having a common interface to all connectors used to access data. The implementation of these connectors can thus present different data through a common interface. An object oriented data model is built on top of this interface.

More specifically, one of the problems with using data from different data sources is the problem of duplication of data. For instance the E-Street dataset may include a building name whose coordinates fall within a MasterMap polygon (for instance a building). The AddressPoint dataset may also include the same building name but at a slightly different position within the building. The interface correlates the building names from the two different sources and identifies that they both relate to the same building, thus avoiding duplication.

4.4 POI Selection

To select POIs used to identify the junction, the appropriate sector ranking is added to the POI rankings and all sectors are marked as ‘in use’. To select a POI the highest ranked POI from the ‘in use’ sectors is selected. The POI is then removed from further consideration and the sector marked as ‘not in use’. The process is repeated to select additional POIs. If all sectors are marked as ‘not in use’, then they are all marked as ‘in use’ again.

4.4.1 Introducing virtual junctions

Sometimes it is necessary to select POIs on a route ‘leg’ rather than at a route ‘junction’. This is normally carried out if a route leg is judged to be greater than a threshold length. One or more virtual 2-arm junctions are introduced on the leg. The position of these virtual junctions are chosen to ensure that the resulting legs are neither too long (i.e. within a percentage, typically 25%, of the threshold length), nor have too many spurs (typically no more than four). Where possible the virtual junction is added at an existing node in the network, otherwise it is introduced part-way along an edge.

4.4.2 Orientation Schematic POI selection

In the case of Orientation Schematics (described above), POIs are identified for the junctions using a modified form of the POI location described above under the heading 'Directions". In this case the 'onRouteFactor' and 'sectorRanking' are always set to zero. Additional sectors are constructed for any Polygons entirely bounded by paths between identified junctions.

4.4.3 Location Schematic POI selection

In the case of Location Schematics (described above), POIs are selected for a location schematic based on their significanceFactor. Other elements of the POI ranking are

ignored. The area of the schematic is chosen to include at least two and ideally more POIs.

5. Segmenter

Once the route has been identified (and optionally geometrically simplified) and POIs have been selected, the entire route is segmented into individually displayable sections.

Different segmentation methods are provided depending on the schematic generation method used. Several schematic generation methods will be discussed later.

5.1 Route segmentation based on significant junctions

In a first method, segmentation is achieved by identifying significant junctions along the route. A significant junction can arise from a variety of significant events. For example significant events include the route changing from one road to another (as determined by the name of the road) or crossing a more important road. These significant events most commonly occur at nodes in the network data. Much source network data contains information about the names and priorities of road segments (edges) in a network. In addition source data can include information about whether a road segment is part of a junction or a roundabout. Thus a node along the route which could be expressed as 'Turn left off road X onto road Y' is significant, whereas 'Continue on road A past a turning on your left into road B' is probably not.

A significant junction may be represented by a node in the network data, or it may be an extended junction, in which case it is represented by a sequence of edges in the network data. Extended significant junctions are identified by looking for nodes along the route which are determined to be significant and then including adjacent edges which satisfy one or both of the following:

(a) the edge is short and the nodes at BOTH ends are 'significant',

(b) the edge is classified as being 'part of a junction/roundabout...' in the source data.

5.1.2 Route Sections

The route is initially split up into 'route sections' by finding those sequences of segments between significant junctions. A route section will include the whole of the significant junctions (if extended) that bound it. Thus consecutive route sections will overlap at extended significant junctions. Consider a route consisting of three junctions: j1, j2 and j3. in which junctions j1 and j3 are simple and j2 is an extended junction. This leads to two route sections; 'j1 to end of j2' and 'start of j2 to j3'. These two route sections overlap because they both contain all of j2.

Complexity of the paths between significant junctions may necessitate further segmentation to improve clarity. Sections are further divided up in order to satisfy further criteria such as maximum number of spurs (insignificant junctions) in a section or maximum length of a section. This is done by recursive subdivision.

For example, the route may be split into three sections as shown in Figure 6.

5.1.3 User Interaction

User interaction may also affect segmentation, as follows. By default, a schematic 'leg view' would display one route section. The scale of the image will be chosen to fit the route section plus some overlap with the previous and next route sections, and any POIs associated with that section.

Therefore a single route section would typically correspond to a 'leg view'. However, the user may interactively choose to switch between leg views and junction views as he or she progresses along the route. If they switch between a junction view of a junction internal to an existing route section (say they switched from a junction view of the two spurs inside the first section in the example), the system may adjust the route sectioning accordingly in order to show a leg view which begins at the current user position. This is simply one example of how user interaction may affect route sectioning.

5.1.4 Processing

The generation, geometrical simplification, POI selection and route segmentation steps are performed once at the start of a routing session when the routing request is first received. The generation of individual schematics is performed on-the-fly when a route update is requested by the user, and is typically (depending on the number of route segments) performed repeatedly for each route segment.

5.2 Segmentation based on simplified junctions

In an alternative method in which the simplified junction schematic generator (described below) is used to generate the route schematics, the segmenter works in the following way.

The segmenter selects the first node on the route and passes it to the simplified junction schematic generator as the seed node. From this seed node, the simplified junction schematic generator identifies a set of one or more nodes which are to be displayed as an extended junction in a single schematic.

The resulting extended junction displayed in a schematic may contain more than one node from the route. Therefore, once the schematic generator has generated the first schematic, the segmenter searches along the route to find the next node which has not yet been included in a schematic. This node is once again passed to the schematic generation module to become the starting point for the generation of the following schematic.

The segmentation of the route into different schematics is therefore achieved implicitly, as a by-product of the schematic generator's identification of extended junctions.

The segmenter may optionally identify only certain significant junctions for which schematics are to be generated, whilst other junctions are considered insignificant and are ignored.

In the case of the node imager schematic generator described below, a simpler segmentation method is also employed, as will be described below.

6 Schematic generator

In a preferred embodiment, the system comprises several alternative schematic generator modules implementing different schematic generation methods. An appropriate schematic generation module is selected depending on the nature of the routing request. For example, different types of schematics may be generated for different types of mobile devices depending on characteristics such as screen resolution. Also, the selection may depend on how the system is configured or may be user configurable. Furthermore, instead of or in addition to generating individual routing schematics the routing application may request generation of an overview schematic representing the entire route.

Embodiments may incorporate some or all of the schematic generators described, and may incorporate other schematic generators implementing different schematic generation methods having some or all of the features of the generators described in any suitable combination. Furthermore, different schematic generation methods may be implemented by a single configurable schematics generation module.

The following examples of schematic generators will now be described:

- Path schematics generator
- Node Imager
- Simplified junction schematic generator

Each schematic generator comprises a POI placement and labelling module which places POIs selected by the POI selector on the schematic and labels the features of the schematic. Similar techniques are used by the different schematics generators to do this. These techniques will be described following the description of the individual schematic generators.

6.1 Path schematics generator

The path schematics generator is typically used to generate schematics for use on large mobile devices. These may be overview schematics of the entire route or leg views showing a leg of the route covering several junctions.

It can also be used on smaller devices to display views of a particular junction.

The operation of a path schematics generator 540 in the context of the routing subsystem will now be described with reference to Figure 18b.

The network route structure generated as described previously is geometrically simplified by a Path Extraction module 542. The operation of this module will now be described with reference to Figures 7 and 8.

The network elements are first condensed into a set of paths, each path being a series of connected route edges sharing the same road name, each forming a simple string of edges. Thus for example in Figure 7, a first path may comprise elements 20,23 and 25, a second path may comprise elements 21 and 22, and a third path may comprise elements 24 and 26.

Each path is then individually simplified. This process involves removing details from, and otherwise manipulating the 2D polyline representation of the path.

For example, road sections that lie within a certain tolerance of being straight are straightened.

Distance tolerance considerations are taken into account as follows. A path is originally defined by a polyline containing a set of coordinates specified by the source data. This polyline is simplified by removing coordinates whilst maintaining the constraint that the simplified polyline lies within a distance error 'd' from the original polyline. For an orientation or location schematic, for example, the value of 'd' is chosen based on the size of the area covered by the orientation schematic. For example, it might be chosen as 1/10th of the maximum extent of the area covered. In

the case of a routing schematic, the distance 'd' may be based on the size of the whole route: for instance 'd' may be one tenth of the size of the whole route. In another example, the value of d may change to reflect the size of the individual path. Further enhancements may constrain the error in the direction of the simplified polyline compared to the direction of the original at the corresponding point. This would be an angular constraint similar to but looser than the one applied at significant junctions.

Particular care over angular tolerance is taken near 'significant junctions' (as defined above), since the relative angular separation of roads at a junction affects the user's confidence.

An example of simplification of the data of Figure 7 is shown in Figure 8. The first path has been straightened out and aligned up and down the page. Element 24 has been straightened out. The angular separation between elements 23 and 24 at node 27 has been maintained.

If some of the paths are above a threshold length, then a new virtual junction is introduced at their mid-point.

The simplified paths produced by the Path Extraction module 542 are used as input to the Path Drawing module (544 on Figure 18b). This module is responsible for drawing the paths in an appropriate alignment on the screen and placing other decoration such as POIs and arrows. Its operation will now be described.

Geometries are arranged:

- to ensure that the alignment of the features on the screen makes best use of the screen's aspect ratio;
- if the destination has already been chosen, and the orientation schematic is being used as the first step in getting the user moving towards the destination, then the orientation schematic may be oriented to ensure that the user's current direction of movement is oriented up the screen (or alternatively left to right, depending on the screen format);

- if the orientation schematic is being used simply to identify the user's location, then the orientation schematic can either be oriented conventionally (i.e. north at the top), or alternatively, to ensure that some significant feature (e.g. the most important road currently in the orientation schematic) be aligned either up or across the screen;
- to align lines with the horizontal or vertical and to fit the most information into the smallest areas.

Each individual routing schematic (generated in response to a route update request received from the mobile device) is based upon a segment of the previously generated and geometrically simplified route, with which a number of POIs will have been associated by the POI selector. This 'segment' may include one or more nodes.

The choice of POIs actually displayed in any given routing schematic is further refined, as described below, and various techniques are employed to improve the clarity of the image, including the following:

- POIs are offset sufficiently from the roads to make them distinguishable if necessary.

- POIs, other icons (such as arrows) and spurs are moved up and down their associated paths to improve clarity without invalidating the fundamental information conveyed (for example, by keeping their relative position to each other consistent). Broadly, the algorithm looks at the classification of a road, its size and whether it is a side road or a crossroads. Depending on the road's importance, it shows a stub or may show more geometry.

- If it is not possible to display all display items without introducing conflicts, items are removed according to a relevancy assessment which takes into account their proximity to the user and any scoring statistics calculated during their original construction (see POI ratings above).

- Path lengths or relative angles or even path segmentation may be adjusted in order to further optimise the clarity of the resulting image.

- More detail may be included in the first routing schematic to aid the user in correctly identifying their location with reference to the schematic.

Examples of schematics generated in this way are shown in Figures 9, 10, 11 and 12.

6.3 Node Imager

The operation of a node imager 560 will now be described with reference to Figure 18c.

A node imager display is used to provide a junction-by-junction "bird's-eye" view of a route. In some embodiments, the node imager 560 only provides junction schematics for significant junctions (such as Figure 13) and omits all other junction schematics (such as Figure 14). Showing the route junction-by-junction is more suitable for small devices where display of the legs of a route between junctions is impractical. The display from a node imager also differs from a schematic (of the types described above and below) in that it provides more detail of the junction and does not alter (that is to say simplify) the junction geometry. This provides enough detail to allow the user to be reassured that they are traversing the correct junction.

The input to the node imager 560 is the set of significant junctions computed by the route segmenter described previously.

The area to be displayed for each junction is calculated by the image bound computation module 562 as follows:

- the map is rotated so that the user arrives from the bottom (for portrait devices) and from the left (for landscape devices). For the initial image the map is rotated so the user leaves via the top (portrait) or via the right (landscape).

- the minimum bounding rectangle (MBR), in this rotated space, is determined for that part of the route that begins a specified distance along the route before the junction, the interior of the junction and a specified distance along the route after the junction.

- the MBR is extended to include those parts of the selected POIs which fall within the search radius of the junction (so that only part of the building outline may be shown).

- a scale and centre for the final image is chosen to maximise the scale at which the image can be displayed subject to showing the entire MBR.

The images are generated on the fly by the image drawing module 564 on a per-junction basis. They are generated by displaying the polygons associated with key features at the junction, specifically the roads and buildings. These polygons provide the necessary detail. Features that represent POIs are highlighted and labelled. Labelling of the image is undertaken as a final stage in the same manner as described below. The route is represented by an incoming arrow on a section of route before the junction and an outgoing arrow on a section of route after the junction. Thus these arrows are unambiguously associated with edges which are not part of the junction itself. This approach does not attempt to dictate to the user how to negotiate the junction, rather it leaves these details to the user 'on-the-street' where additional constraints may be visible.

Figures 13 and 14 are examples of schematics generated by the node imager.

6.4 Simplified junction schematic generator

The aim of the simplified schematic generator is to produce a simplified, abstract representation which is suitable for display on small devices but which retains sufficient information so as to be representative of the real world as seen by an observer and user of the schematic.

A particular factor affecting the usability of a schematic-based route guidance application concerns the treatment of complex junctions. A road junction may be considered complex if it involves well-defined road artefacts such as roundabouts, dual carriageways or traffic islands or if the number or geometry of roads meeting in a small region makes it difficult to resolve the road network into single isolated nodes that a pedestrian would consider to be single junctions.

An example of a complex junction is shown in Figure 15, which shows a map section covering a complex junction as supplied by Ordnance Survey in 'Master Map' format.

The map represents the real-world geometry of the road network that constitutes the complex junction, as well as the buildings present in the area, which are shown in outline. What appears to be a triangular traffic island can be seen at the centre of the image. As a whole, the map provides a realistic representation of the real world.

A pedestrian might perceive a complex road network, such as the road network of Figure 15, in many different ways, depending on how they approach the junction(s), where the pavements are, whether it is possible to traverse the traffic island on foot, or on more personal preferences. Examples of how a human might typically represent this complex junction in a hand-drawn sketch map are given in Figures 16A, 16B and 16C, though naturally, many other ways of drawing the junction in an abstract way are possible.

The road network data provided by geographical data suppliers is typically oriented towards how a road user would perceive and navigate this junction.

Figure 17 shows the data provided by TeleAtlas for the same complex junction. Some data suppliers supply further information on the road network in the form of other property flags on the roads. In this particular case, the road elements displayed in bold are flagged as "dual carriageway". The lighter road element is flagged as being "part of a junction". Nodes in the network are labelled A to G. The node G has been artificially inserted by TeleAtlas into the data to indicate the corresponding point on the other side of the dual carriageway to the node B.

A simple approach to junction schematic generation for a pedestrian route traversing this network might treat each node as a junction. For example, for a route entering at node C and leaving at F each of the nodes C, G, E, F may be displayed as junctions in turn and in isolation. This could lead to much user confusion since it might appear that the route meets a fork at C, continues straight on at G, joins another road at E and then forks again at F.

Generating a schematic which is simplified but representative of the real world from the available data involves the following steps:

- Identifying which parts of the road network resolve into individual junctions as would be perceived by a pedestrian. Such junctions correspond to sets of road network elements and are termed 'extended junctions'.
- Generating a simplified representation of each extended junction
- Generating a schematic depicting the simplified extended junction along with context information

The simplified junction schematic generator carries out the above steps in order to produce a simplified, abstract representation of a junction. Its operation in the context of the routing subsystem will now be described with reference to Figure 18a.

Routing application 100 supplies a route request to the routing subsystem 200, specifically to router 210, which identifies the required route, as described above. The route is passed to segmenter 230, which provides successive seed nodes (for each route segment to be displayed) to simplified junction schematics generator 240. Schematics generator 240 generates a graphical schematic based on the received seed node and outputs this to output 260.

Schematics generator 240 comprises an extended junction identification module 242, a junction simplification module 244, a junction drawing module 246 and a POI placement and schematic labelling module 248.

Extended junction identification module 242 identifies an extended junction based on the seed node supplied by route segmenter 230. This is achieved by growing outwards from the node, adding road network elements to the set of network elements forming the extended junction if that road network element conforms to one of a number of junction criteria identifying it as belonging to part of a junction. In some cases, no network elements may be found which satisfy the junction criteria. In this case the extended junction identified will comprise only a single node, namely the seed node. The extended junction identification module will be described in detail below.

Junction simplification module 244 creates an abstract representation of the extended junction identified by extended junction identification module 242. This abstract junction describes the extended junction as a point in the network, with multiple junction exits leaving it. These junction exits correspond to the road elements that meet at the nodes of the extended junction but which are themselves not part of the extended junction. The abstract junction is also simplified geometrically, with real-world angles being changed to angles more suitable for schematic display.

However, not all extended junctions can be reduced to a single point, since this could be misleading to a reader of the schematic. For example, where exits from an extended junction are essentially parallel but spaced apart (staggered exits), showing these exits leaving from a single point may lead to a confusing schematic. In such cases, an extended junction cannot simply be shown as a single point, and a more complex representation is needed.

The generation of a simplified, abstract junction representation will be described below.

Once the junction has been simplified, junction drawing module 246 creates the graphical representation of the simplified junction.

POI placement and labelling module 248 adds context information such as POIs and labels to the graphical representation of the simplified junction to produce the completed schematic.

6.4.1 Extended junction identification module

Extended junction identification module 242 will now be described.

An extended junction comprises one or more nodes, the set of internal edges connecting those nodes if any, and a set of external edges leading to and from the extended junction.

A representation of an extended junction isolated from the road network data of Figure 17 is shown in Figure 21.

The extended junction is represented as a set of network elements comprising the set of junction nodes, the set of internal edges and the set of external edges.

The extended junction is isolated by growing a network of junction edges outward from the seed node, adding new edges to the extended junction that meet the junction criteria, until no more edges can be added.

Beginning with the seed node, all connecting edges are added to a set of unexplored edges. Then, each unexplored edge in the set is examined in turn to determine whether it meets any one of a set of junction criteria. If the edge meets one of the criteria, it is considered to be part of the extended junction. The edge is then removed from the set of unexplored edges and added to a set of internal junction edges. These internal junction edges are edges that are part of the extended junction.

The node at the other end of the junction edge thus found is added to a set of unexplored nodes for further consideration.

If the edge being considered does not meet the criteria, then it is considered to be an external edge, meaning that it corresponds to a road segment leading into or out of the extended junction.

Once all edges connecting to the seed node have been considered in this way, processing continues with the next unexplored node and its connecting edges are

considered for inclusion in the extended junction. The algorithm terminates when the set of unexplored nodes is empty, meaning that no further edges can be added to the extended junction. Throughout the process, edges which do not satisfy the junction criteria are considered not to form part of the extended junction and are therefore identified as external edges.

The algorithm is summarised in the following pseudo-code, in which:

- `UnexploredNodes` is the working set of nodes to be considered for inclusion in the extended junction
- `JunctionNodes` is the set of nodes forming part of the extended junction
- `JunctionEdges` is the set of edges forming part of (i.e. internal to) the extended junction
- `MeetsJunctionCriteria (edge e)` is a boolean function which applies the junction criteria to the edge e and returns *true* if any of the criteria are met and *false* if not.

```
UnexploredNodes := {SeedNode}
JunctionNodes := {} ; JunctionEdges := {}; ExternalEdges := {}
While UnexploredNodes is not empty {
        Remove next node n from UnexploredNodes
        Add n to JunctionNodes
        For each edge e adjacent to n not already in JunctionEdges {
                If MeetsJunctionCriteria (e) then
                        add e to JunctionEdges
                        add node at other end of e to UnexploredNodes
                else
                        add e to ExternalEdges
                end if
        }
}
```

Junction criteria

The criteria applied to determine whether a network edge should be taken to be part of an extended junction will now be described.

Criterion (1). Flags set in the source data. The source data comprises flags which indicate whether a certain road element is part of a junction. In the example of Figure 17, the element from A to E is flagged as being part of a junction by TeleAtlas. A road element flagged as being part of a roundabout also satisfies this criterion.

Criterion (2). Length of the network element. If the road element is shorter than a certain threshold length (for example, 20m) then it is considered to be part of a junction. In some embodiments, different thresholds may be applied depending on the road classification size or width of the road element.

In the example of Figure 17, the element E to F may well satisfy this criterion.

Criterion (3). Dualness of the network element. If a network element is flagged in the source data as being the other side of a dual carriageway to another element that has already been identified as belonging to an extended junction, then it will also be added to the extended junction. In the example of Figure 17, if the element from A to B is added to the extended junction, then so will its dual, E to G. This duality pairing is derived from the source data.

Criterion (4). Elements of traffic islands. Road elements surrounding traffic islands are considered to be part of an extended junction. If (as, for example, is the case for the TeleAtlas data), the property of being adjacent to or part of a traffic island is not flagged in the road network source data, it is possible to identify algorithmically the likelihood that a given set of network elements form part of a traffic island from the network data that is available.

A traffic island is detected if the road elements correspond to a particular configuration.

This configuration is illustrated in Figure 19. Specifically, a traffic island is detected where a set of network elements is found that comprises two sides (AB, AC) emanating from a node (A), and joined by no more than two edges (BD, DC or simply BC); and that further satisfies the following rules:

- All roads at node A must have the same (or no) name. There may be more edges at A than depicted in Figure 19 as long as they satisfy this rule.
- B and C must be connected by at most 2 road elements, i.e. the node D may or may not exist. If there are two road elements, they must have the same name. There are some allowable exceptions to this rule:
    - B and C need not be connected if instead they are adjacent to two paired elements of the same dual carriageway; this would correspond to the case of a road splitting into two at a traffic island.
    - BD and DC need not have the same name if they are flagged as part of a roundabout or junction.
    - BD and DC need not have the same name if one is very short (less than 3m).
- AC and AB must be shorter than a specified length (for example, 75m).
- There must be no (MasterMap) buildings inside the region defined by ABDC. This last rule is applied as a verification check.

If the network satisfies these rules, then it is considered to constitute a traffic island. All of the bold elements AB, BD, DC and AC are considered to be part of the same extended junction.

An algorithm suitable for identifying whether a given edge is part of a traffic island having the above characteristics will now be described.

To be considered part of a traffic island, a given edge must be part of a network structure matching the pattern described above. The edge itself must therefore correspond to one of the edges AB, AC, BD, and DC, or, in a simpler arrangement, must correspond to an edge BC.

Furthermore, the requirements described above dictate that the edge in question must either be an AB or AC type edge, or adjacent to such an edge. In fact, since the pattern is symmetric, an AB type edge is equivalent to an AC type edge with respect to the requirements, and a BD type edge is equivalent to a DC type edge. It is therefore only necessary to consider whether the edge in question is an edge of type AB or is adjacent to an edge of type AB.

The problem of whether a given edge is part of a traffic island can hence be solved by determining whether either the edge in question or another edge adjacent to it is an AB type edge within a traffic island pattern of edges, and, in the event that an adjacent edge is such an AB type edge, whether the given edge is part of that pattern.

To achieve this, a set of directed edges is first constructed containing
a) the given edge itself in both directions (e.g. XY and YX);
b) all edges adjacent to the given edge, in both directions;

Each directed edge in the set is then tested to see if it is an AB type edge. This is done by attempting to construct a network around the edge corresponding to the pattern assuming that the edge is an AB type edge. If it is not possible to construct such a network, then the edge is not an AB type edge. If it is possible to construct such a network, then the network constructed represents a traffic island in the sense defined above. If the traffic island contains the given edge, then processing stops, since it is then known that the given edge is indeed part of a traffic island, and so Criterion (4) is met. If not, testing continues on the remaining directed edges.

This algorithm is illustrated by the following pseudo-code.

```
FUNCTION Is_Part_Of_TrafficIsland (Edge) RETURNS boolean
        Generate set of Edge + all adjacent edges XY
        For each Directed_Edge in both directions XY and YX
                TrafficIsland := Identify_TrafficIsland (Directed_Edge)
                If TrafficIsland contains Edge THEN
                        exit function returning "true"
                End if
```

End for each

No traffic island has been found which contains the edge, so exit function returning "false"

END FUNCTION

FUNCTION Identify_TrafficIsland (Directed_Edge AB) RETURNS set of edges

If AB longer than threshold

it is not part of a traffic island – exit function returning an empty set of edges (meaning that no traffic island has been identified).

Otherwise, identify each further edge AX leaving A having a different road name to AB. If there is one, exit.

Otherwise, for each edge AX, check the following:

Is AX shorter than the threshold length? If no, exit.

Is there a path of length 1 (XB) or length 2 (XY,YB) from X to B? If no:

Are AB and AX flagged as being two sides of the same dual carriage way? If no, exit.

a potential traffic island has been found consisting of AB, AX and either XB or XY, YB.

Check if line from midpoint(AB) to midpoint(AX) intersects building in Master Map data. If no, return traffic island.

END FUNCTION

Consider the network depicted in figure 17 for an illustration of how the extended junction criteria are applied.

Starting at node F, the only adjacent element to be part of an extended junction is EF, based on criterion (2), its length. The node E is then analysed. The element EA is part of the same junction due to criterion (1), being flagged in the data. Despite the fact that there is in reality a traffic island between them, EG and AB are not identified as being part of a traffic island (and hence are not part of the junction), due to the extra complexity introduced by the nodes B and G.

Therefore the extended junction comprises nodes F, E and A, and the road elements EF an EA. All the other roads meeting at these nodes are considered external to the extended junction.

7.4.2 Junction simplification module

The junction simplification module 244 will now be described.

The extended junction identified by the extended junction identification module defines the road network content of the schematic to be generated. A simplified, abstract representation of the extended junction is then generated by the junction simplification module for inclusion in the junction schematic.

In the example of Figure 17, the extended junction comprising FEA has four exits; one to the North corresponding to the exit from F, two to the West corresponding to F and A, and one to the East corresponding to EG and AB.

The extended junction is defined by the set of nodes forming part of the junction, the network edges internal to the extended junction (i.e. edges connecting the junction nodes), and the network edges external to the extended junction, which are the edges leading into and away from the extended junction. These will be referred to as junction exits.

Where it is necessary to consider the position of an exit (for further stages in the algorithm defined later), this is taken to be the position of the node that the exit leaves from.

The extended junction notionally has a centre defined by the average position of the network nodes it comprises.

In the majority of cases (including the trivial one where the junction comprises a single node), an acceptable schematic image can be generated simply by drawing a diagram with a single road corresponding to each exit all leaving from the same point, namely the extended junction centre. An example of this is given in Figures 20A, 20B

and 20C, in which Figure 20A shows the MasterMap data for a complex junction, Figure 20B shows the road network data (for example from TeleAtlas) corresponding to the same junction, and Figure 20C shows a simplified schematic of the junction.

The benefit of conceptualising the junction as a point with various exits is that at the time the schematic is generated, the exact angles and line work displayed can be manipulated to give a more regular appearance, for example exits can be 'snapped' to being perpendicular or anti-parallel to each other within some tolerance, as in Figure 20C.

In some cases however, it is not acceptable to draw all exits emanating from the same point. For example, in the complex junction shown in Figure 17, there are two distinct but near-parallel exits leaving to the west. Another reason for not wanting to draw two exits at the same point is if the junction is obviously staggered.

In these cases, there are further steps to the schematic generation process. In order to minimise the complexity of the resulting schematic but still convey the true form of the junction, the junction simplification module attempts to find a grouping of the exits where each exit in a group can be displayed as emanating from the same point. Such groups are termed 'clumps' of junctions. Exits will only belong to the same clump if they can be displayed at the same point. The junction simplification algorithm attempts to minimise the number of clumps, and hence to maximise the number of exits belonging to each clump.

The junction simplification algorithm comprises the following steps:

- Defining the junction exits based on the external junction edges
- Grouping the junction exits into clumps
- Identifying alignment relationships between clumps
- Prioritising the alignment relationships

Defining the junction exits

The simplification algorithm first generates the set of junction exits based on the extended junction's external edges. Each junction exit has the following properties associated with it:

- The external edge corresponding to the exit
- The angle at which the external edge leaves the junction
- The position of the exit, which is taken to be the position of the junction node to which the external edge connects

If two exits are part of the same dual carriageway, they are considered to be the same exit.

Since the external edge corresponding to an exit (which is a network edge from the geographical source data) is not necessarily straight, a representative angle is chosen. A variety of methods for determining the angle associated with an exit are available, of which the following are examples:

- by calculating the average angle of the polyline segments over a certain distance (for example, over 50 metres)
- by grouping the angles of the polyline segments over a certain distance into a number of distinct ranges, and selecting an angle based on the most frequently occurring range
- if the angle of a polyline segment exceeds a threshold (for example, 90 degrees), the remainder of the polyline may be ignored
- by calculating the angle of a straight line connecting the starting node to a point a certain distance along the polyline
- If the angle selected based on one of the previous methods would define an exit that would intersect a building (as given by the MasterMap data), this may correspond to a road bending around a building. In this case, a different angle can be selected.

In the case of a dual carriageway defined by a pair of edges flagged as such in the source data, the angle and position attributes are taken to be the respective averages of the edges' angles and starting positions.

Grouping junction exits into clumps

Once the set of exits for an extended junction have been determined with their angle and position attributes, clumps of exits are identified. A clump of exits is a grouping of exits which can be drawn from the same point.

The first step in identifying clumps is to identify pairs of exits which cannot belong to the same clump. This could be either because they are near anti-parallel but sufficiently separated in position that they correspond to a 'staggered' pair of exits, or because they are sufficiently parallel that they cannot be displayed at the same point. The terms 'near' and 'sufficiently' in this context are determined by constant factors set by experimentation. Each exit in such a pair is put into its own, new clump.

All possible pairings of exits are exhaustively tested to determine if they are either parallel to within a given threshold angle, or anti-parallel to within a threshold angle and separated by a distance greater than a threshold distance.

The second step identifies exits that cannot belong to only one of the clumps made so far on the basis that if they were put into one of the clumps, this would destroy a 'near anti-parallel' relationship that the exit holds with an exit in another clump.

The third and final step in the clumping algorithm assigns exits not yet in clumps to the most appropriate existing clump. To do this, the exits are ordered 'clockwise' around the junction. This clockwise ordering is first done on the basis of the position of the exit around the centre of the extended junction. Exits which are at the same position are further ordered on the basis of the angle between each exit and the vector subtended from the centre of the junction to the position of the exits.

Exits are then assigned to the closest clump whilst ensuring that this ordering of the exits is preserved. The assignment algorithm considers the exits in their clockwise

ordering in sequence. Starting with the first exit, this is assigned to the nearest clump. The algorithm continues around all exits in a clockwise direction, until all exits have been assigned.

Example

Referring once again to the sample network data illustrated in Figure 17, as an example of how the clumping algorithm works, consider an extended junction comprising nodes F, E and A.

Figure 21 shows this extended junction with exits labelled. Since external junction edges EG and AB are flagged in the source data as being two sides of the same dual carriage way, these are identified as the same exit by the junction simplification module.

Therefore, Figure 21 shows a total of 4 exits labelled e1, e2, e3 and e4.

In the first step of clump identification, the exits are considered to determine which exits need to be assigned to separate clumps. In the example, e3 and e4 are assigned to two separate clumps C1 and C2, since they are near parallel. At this stage, exits e1 and e2 are yet to be assigned to clumps.

In the second step, the remaining edges are considered. Exit e1 cannot belong to the clump c1 (so far containing e3) since it is near anti-parallel with e4 (in clump c2). By the same token it cannot belong to c1. Such exits are put into new, separate clumps; here exit e1 is put into a new clump C3.

Now that the clumps have been defined, the remaining exits are assigned to their respective nearest clump. Here exit e2 is assigned to clump C1.

Identifying alignment relationships between clumps

The next stage in forming a schematic for the junction involves identifying the relationships between the clumps that relate to important visual structure of the

junction as perceived by a user. These relationships will define how the clumps are positioned within the schematic. In the example of Figure 22, the fact that e1 and e4 are near anti-parallel defines a relationship between C2 and C3; referring to the real-world geometry in Figure 15 it is clear that most users would perceive these exits as belonging to the same road. The aim is to retain as many of these relationships as possible whilst minimising complexity of the schematic by using parallel and perpendicular angles and drawing horizontal and vertical lines wherever possible.

The set of these relationships is described by a matrix of alignments of each clump with respect to all the other clumps. This is referred to as the alignment matrix. An alignment is a vector which describes the 'best' relative position of one clump with respect to another according to the strengths of the relationships between each pair of exits in the two clumps involved. These relationships may either be parallel or anti-parallel alignments of the pair of exits.

A parallel relationship corresponds to the real-world situation of a pair of staggered exits. An anti-parallel relationship corresponds to the situation of two road segments connected to each other in what is substantially a straight line.

Therefore, if a near-parallel relationship between exits, then it may be possible (and advantageous) to draw these as staggered parallel exits off the extended junction. An example of this is illustrated in Figure 23A, showing the original relationship of two near-parallel exits, and Figure 23C, showing a simplified representation of that relationship.

Likewise, if two exits have a relationship to each other that is close to anti-parallel then they can be drawn in a simplified way by straightening them and connecting them in a direct line. This is illustrated in Figure 24A, showing two exits having a near-anti-parallel relationship, and in Figure 24C, showing the corresponding simplified representation.

The strength of a relationship relates to how close the actual real-world geometry is to obeying the parallel or anti-parallel relationship. It is defined in terms of the

perturbation that would be required to move the exits so that they could be drawn in a manner which completely satisfies the relationship.

In the case of an exit corresponding to a dual carriageway, the geometry of both sides of the road is taken into account. Further refinements may involve taking the road names into account, in order to increase the probability that a single road through the junction is displayed as a straight line. 'Importance' (i.e. dual carriageway, major road, minor road) of the roads may also be taken into account.

Calculation of the strength of a near-anti-parallel relationship is illustrated in Figure 24B. Exits 422 and 424 (shown as arrows) are almost anti-parallel. To satisfy a fully anti-parallel relationship (corresponding to two road segments connected in a straight line), apart from adjusting the exits' angles, one of the exits would need to be moved by a certain distance (the perturbation). The perturbation vector 430 describes this shift required to satisfy the relationship.

Calculation of the strength of a near-parallel relationship is illustrated in Figure 23B. Here, exits 402 and 404 are almost parallel (corresponding to staggered exits). Perturbation vector 410 describes the shift required to draw the exits as staggered exits perpendicular to a straight connecting road-segment.

In either case, the strength of a relationship is anti-proportional to the length of the perturbation vector, that is to say, the shorter the perturbation vector is, the stronger is the relationship.

In some embodiments, in addition to the length of the perturbation vector, the perturbation angle (shown as α in both Figures 23B and 24B) is also taken into account in determining the strength of a relationship.

To determine the relative placement of two clumps of exits, the strongest relationship between any pair of the clumps' exits is identified.

For each pair of clumps an entry is created in the alignment matrix describing the strongest relationship between any exit in the first clump and any exit in the second clump.

Anti-parallel relationships correspond to two exits entering and leaving either side of the extended junction in what an observer may typically perceive as an essentially straight-line connection, and it is hence assumed that such relationships have greater significance for the observer than parallel, staggered-exit type relationships.

The junction simplification algorithm therefore searches for the strongest anti-parallel relationship first, and selects this as the strongest relationship between the two clumps under consideration. If no anti-parallel relationships can be found, then the strongest parallel relationship is the strongest relationship between the clumps.

This relationship is entered in the alignment matrix and becomes the alignment constraint for the given pair of clumps. If neither parallel nor anti-parallel relationships exist between any of the exits of the two clumps, the corresponding entry in the alignment matrix is left empty, essentially leaving the relationship between the two clumps undefined.

This algorithm may be summarised as follows:

For each pair of clumps <C1, C2>
    Find strongest anti-parallel relationship of all pairs <e1 ∈ C1, e2 ∈ C2>
    If none found:
        find strongest parallel relationship of all pairs <e1 ∈ C1, e2 ∈ C2>
    Enter strongest relationship found into alignment matrix for C1, C2, or leave blank if none found

In the case of a dual carriageway, both road segments are considered. The strongest relationship between an exit representing a dual carriageway and another exit will therefore always be the stronger of the two relationships between either side of the dual carriageway and the other exit.

In the example of Figure 22, there is an anti-parallel relationship between e1 and e4. This relationship is very strong since the south side of the road defining e1 and the road defining e4 are very nearly parallel. There is also an anti-parallel relationship between e1 and e3, although this is not as strong as that between e1 and e3. The entry in the alignment matrix describing the best alignment of C2 with respect to C3 is a vector parallel to the average of the direction of e4 and e1.

Considering the clumps C2 and C1, there is a parallel relationship between e3 and e4, and a perpendicular relationship between e2 and e4. In this case, the parallel relationship is this stronger due to the actual angles and positions involved. In actual fact these two relationships are not mutually exclusive since it is possible to draw a diagram where both are satisfied. The entry in the alignment matrix describing the best alignment of C1 with respect to C2 is a vector perpendicular to the parallel relationship defined by the average of the directions of e3 and e4.

The alignment matrix is filled with these vectors describing the best relative positions of the clumps. Sometimes two clumps will have no particular good alignment, in which case the relevant entry in the matrix will be empty. In mathematical terms, the matrix is an upper-diagonal matrix describing constraints on the relative positions of the various clumps.

The alignment matrix defines the strongest relationships between every pairing of clumps in terms of an alignment vector and the strength of the relationship. As previously stated, the strength is given by the perturbation necessary to shift one exit (relatively to the other) into the required position. The alignment vector gives the angle and length of a line connecting the two exits once so shifted.

<u>Prioritising the alignment relationships</u>

In order to draw an optimal schematic, the junction simplification algorithm searches for a positioning of the clumps which best satisfies the constraints specified by the alignment matrix. In general, it will not be possible to satisfy them all or there may be

some positions which are no better than others – in other words, the system may be over- or under-constrained.

The junction simplification algorithm first identifies the strongest constraint in the matrix (that which would require the least perturbation of the network in order to be satisfied) and fix the relative positions of the two clumps involved. This constraint is added as the first entry to an ordered list of constraints, and the corresponding matrix entry is removed.

The relationships between the remaining unfixed clumps and each other and the already fixed clumps are then assessed by searching the remaining non-empty entries in the matrix. The strongest remaining constraint defines the position of another clump and the fixed ones or a non-fixed one. This constraint is added to the ordered list (in second place), and its entry is again removed from the alignment matrix. This process is repeated until there are no constraints left in the alignment matrix. Arbitrary constraints between the remaining unfixed clumps (if any) are then invented on the basis of their actual relative position.

Other known optimisation techniques can also be used to identify an arrangement of clumps that best satisfies the constraints specified by the alignment matrix.

The ordered list of constraints thus obtained defines a priority ordering on the constraints.

This provides a plan for drawing the schematic. In the example of Figures 21 and 22, the resulting plan is to draw C3 relative to C2 in a direction defined by e1 and e4, and C1 relative to C2 in a direction perpendicular to e2 and e3. This plan is provided as input to the junction drawing module 246.

Although it is conceivable that the above algorithm may result in schematics which involve intersecting junctions or otherwise inaccurate representations, it has been found in practice to result in satisfactory solutions.

6.4.3 Junction drawing module

The junction drawing module 246 will now be described.

Once the plan for drawing the extended junction has been generated by the junction simplification module, the schematic can be drawn.

The constraints defined by the plan are processed in turn. One clump involved in the first constraint is fixed arbitrarily (for example, to the centre of the drawing area). The other clump involved in the constraint is then drawn at a fixed distance to the first clump at the angle described by the constraint after having been 'snapped' to an aesthetic value (such as horizontal, vertical or 45 degrees if possible). In the case of three or fewer clumps in total, this fixed distance is computed on the basis of screen size and the actual length of the constraint is ignored. If there are four or more clumps, the distances between the clumps are based proportionally on the screen size and the length of the constraint (which will correspond roughly to the original distance in the real world). This behaviour for four or more junctions is necessary for extremely complicated junctions since the extra simplification introduced by ignoring the lengths can destroy the structure of the junction.

The location of all clumps thus fixed defines where the exits belonging to each clump are drawn. The angles of the exits are snapped to preferred values (for example to units of 22.5 degrees or 45 degrees). No internal structure is shown for the extended junction.

An example of the abstract junction representation derived by the junction simplification module representing the extended junction of Figure 21 is depicted in Figure 25. The resulting schematic is shown in Figure 26. The extended junction itself is simply represented by a triangular shape of at the centre of the schematic, with road stubs representing junction exits leading off it. All angles and lines are horizontal and vertical or at 45 degrees and line lengths are equal yet the perceived structure of the junction has been preserved.

The length of road stubs is selected based on the road classification and on whether the junction exit in question is on the route. The possible lengths are fixed for each type of mobile device / resolution, such that the desired emphasis is achieved, for example displaying longer road stubs for exits which are part of the route than for exits that are not.

The schematic is also oriented such that the route enters the schematic vertically from the bottom of the screen.

The above discussion concentrated on an extended junction representing a complex real-world junction. The steps involved in the case of a roundabout are the same until the clump alignment matrix is constructed. Exits from a roundabout are still resolved into clumps, but the plan for positioning the clumps on the schematic is constructed by describing the position of the clump relative to the centre of the (circular) roundabout.

Leg views

The simplified junction schematic generator is particularly suitable for generating schematics for display on small or medium-sized mobile devices. However, the same junction simplification method may be used to produce schematics of larger route sections corresponding, for example, to a leg of a journey. Such schematics are suited for display on a large mobile device.

Such a leg view typically represents several junctions in the same schematic by chaining together schematics for individual extended junctions with straight or dotted lines, as exemplified in Figure 27B, which is a schematic representation of the real-world network shown in Figure 27A.

The distance separating the junctions in the schematics need not reflect the real world at all; the pertinent information to the user is how to navigate the junctions. Actual distances in the display are chosen to fit the phone screen appropriately. Road network nodes in between junctions at which the user needs to change direction (make a turn) may be considered insignificant and ignored completely, as has happened in

Figure 27B. If the road turns significantly in the real world, the schematics are chained together using a kinked line or a curve. The fact that the separation of the junctions on the screen may not reflect distances in the real world can be conveyed using conventional map symbols. These ideas are illustrated in Figures 28A, 28B and 28C.

6.4.4 POI placement and labelling

The POI placement and labelling module adds context and label information to the schematic.

Points of interest will have been previously identified by the POI selector for the entire route, and each point of interest selected will have been associated with a particular node along the route.

In the case of a schematic generated by the simplified junction schematic generator, all points of interest associated with the extended junction nodes which lie on the route are considered for inclusion in the schematic. Points of interest which are located near nodes or road segments not on the route will generally not have been selected by the POI selector and are therefore not considered.

Points of interest are displayed on the schematic in one of several different ways, depending on the type of schematic and other constraints (such as screen size):

- As a point
- As a building outline or shape
- As an abstracted frontage

POI display as a point

This is typically used for small displays, or to avoid clutter where several POIs are displayed on path schematics.

Figures 9 to 12 are examples of schematics in which points of interest are displayed as points.

POI display as a building outline or shape

An example of this has been described above for the node imager, where POIs are shown as shaded building outlines.

POI display as abstracted frontage

In this mode, an abstract representation of the frontage as visible from the street is generated.

The following properties of a POI near a junction are considered when displaying points of interest in this way:

1) Whether the POI can be seen at all from a given road
2) How large the POI appears to be from a given road. This is classified as one of:
    a) Small
    b) Medium
    c) Large
3) How close the POI is to the junction. This is classified as one of
    a) At the junction
    b) Near the junction
    c) Not near the junction

Other properties of the POI, such as its shape, area or distance from the road are considered less important. The property of whether the POI can be seen from a given road is particularly important in the case of private houses, since if these are simply labelled as the number part of their address then it is important to indicate which road this address lies on.

When a POI is to be displayed in the context of a junction schematic, the above properties are calculated for the POI with respect to the two exits that enclose it at the

junction. These two exits are those to the left and to the right of the junction when viewed from the centre of the junction. The properties are calculated using the Ordnance Survey MasterMap geometry of the building.

1) is calculated by determining whether a line drawn from the closest point on the geometry building to the road to this closest point on the road intersects with any other buildings.
2) is calculated by projecting the geometry of the POI onto the road and measuring the length of this projection.
3) is calculated by projecting the geometry of the POI onto the road and measuring the distance from this projection to the junction.

Once these properties of the POI have been calculated, they provide an abstract description of the POI and the true geometry of the POI is discarded.

To display this information, it is possible to draw the frontage of the POI along each of the roads from which it is visible. The fact that the display only represents this frontage rather than the actual two-dimensional shape of the building is indicated to the user using appropriate line styles.

An example is shown in Figures 29A and 29B. Figure 29A shows the Ordnance Survey MasterMap data for a given junction. A building selected for display as a POI is shown shaded. Figure 29B shows a simplified junction schematic of the junction, with the abstract representation of the POI displayed, indicating the frontage of the building.

In Figure 29B, the junction has been simplified to an exact crossroads. Although the building is longer in one direction than it is in the other, this is not relevant to a user at the junction; its property is 2c) (large) with respect to both roads. Similarly, the fact that it is further from one road than another is not relevant. The POI is at the corner of the junction and can be seen from either road.

Figures 30A and 30B show a similar example for a different POI at the same junction.

In this case, the POI is only visible from one road. Its frontage along this road has been classified as being of medium length. A user approaching the junction along any other road (from either direction) will immediately understand that he may not be able to see the POI until he reaches the junction.

The styling, lengths and offset from the road of the POI display on the schematic are all set based on the mobile device type and screen resolution to optimise the space used and the aesthetic appearance of the display and are not affected by the real world geometry of the POI, save that there are different values used for the abstract properties 2 a) b) or c) and 3 a) b) or c) of the POI described previously.

This technique of resolving the POI into an abstract frontage along two roads (or in the terminology of extended junctions used above, two junction exits) allows for much flexibility when determining the visual display of the schematic; the exits may be positioned or rotated by the junction display algorithms yet the POI display will remain consistent.

6.5 Location schematics

A variation of the simplified junction schematic generator described above can be used to generate schematics representing an overview of a location (rather than a route segment). Such a location schematic can be used to provide general information about a location, or can be used as an orientation schematic to allow a user to determine their location to greater accuracy within a known area, typically provided by a network location fix.

In order to provide pertinent information to the user within the restrictions imposed by the limitations of mobile device display technology, the location or orientation schematic presents a simplified view of the user's location. Such simplifications include the removal of less relevant information and straightening curved roads within certain tolerances, although the angular interrelationship between roads at junctions is generally preserved.

All the network nodes within the known area are identified by a spatial search.

These nodes are then fed to the extended junction identification module. The output of this module is a set of extended junctions each of which contain a set of one or more of the original nodes; the extended junctions describe a grouping of the network nodes.

These extended junctions are then simplified by the junction simplification module 244 and can be drawn by the junction drawing module 246. POIs may be displayed in the context of each of the extended junctions by the POI placement and labelling module 248 or treated as separated entities to be displayed on the schematic in their own right.

The stylised network in the orientation schematic is based on the junctions identified above together with those (parts of) non-junction network elements that fall into the location-fix area.

The location or orientation schematic thus covers the entire area of the location fix. It presents a stylised image based on network data as described above along with a selection of POIs and other context information.

For instance, the orientation schematic could represent multiple exits from a large building or other structure/area (e.g. office block, tube station, car park). In the case of exits that do not lie at actual road junctions, a 'virtual junction' is created at the exit. A virtual junction is any point that is not considered to be a road junction by the underlying network data, but is treated as a junction by the routing application for the purposes of determining a route or guiding the user.

Off Route POIs

The POI ranking scheme described above may be augmented so that, when displaying a route using POIs, off route 'hints' or 'signposts' to locations of interest can be displayed. An example of such a signpost may read 'British Museum 200m this way'. The signposts could indicate something that a user has expressed an interest in (e.g. favourite coffee shop, a tourist passing something in their MyPlaces list), or

something that a service provider wishes to attract to the user's attention (e.g. advertising).

This could involve showing icons having well-known symbols, for example, the McDonald's "M" or the London Underground logo; or a cross symbol for churches..

Labelling

Once a schematic has been assembled, the image is labelled. The number of features that are labelled is limited depending on the available screen space. For each label, a discrete set of possible locations for the label is calculated by taking possible points on the geometry of the item being labelled, with a minimum and maximum separation, and then calculating label positions above, below, left and right of each point at a range of distances.

For each possible location, the labelling algorithm also generally calculates separate single and multi-line 'positions' and further positions where the label is hyphenated.

A 'cost' for each of these positions is calculated, involving proximity of the label to the item being labelled, conflicts of the label with other display items, degree of overlap with other items, conflict with other labels (and their leaders) etc. Priorities are assigned to display items which should be avoided (for example, a road that forms part of the route has high priority, whereas a side road has lower priority) and to items to be labelled (the next road that the user has to turn into has high priority, whereas a side road half way along a segment has low priority; large POI buildings near junctions have high priority, small ones have lower priority). No possible position is discounted at this stage, although a high cost may be associated with it if many conflicts are found.

A dummy "invisible" cost is assigned meaning that there is a certain cost associated with a label not actually being shown. This cost value is chosen so that some particularly bad positions are considered to be more costly than not being shown at all. The cost function assigns cost penalties to labels where the label interacts with

the background geometry, or the road, or depending on whether it can be displayed in a single line or on several lines or whether it would be hyphenated.

The cost function also depends on the distance of the label positioned from the labelled item. Each item to be labelled has a priority - initially, only the highest priority labels are considered, for example, the top five labels, and the priorities are decided by what kind of item is to be labelled. For example, the road leading out of the schematic, in terms of the route, is given the highest priority followed by the main point of interest in the schematic followed by the road leading into the schematic.

The optimal configuration for all labels is sought by considering the solution space of all combinations of all the label positions. Given a potential solution (a configuration of all labels, each in one of their possible locations), the solution is ranked by assessing the cost of each label position, and the conflicts of the labels in that position with each other. This is a classic optimisation problem which may be solved by exhaustive searching, simulated annealing or other appropriate known methods.

For the highest priority points of interest, the cost of different label positions is calculated and the best final position is then determined by trying to optimise the combination of label positions for the high priority items. This could result in some not being labelled because, in the particular combination, the label cost exceeds the cost of not being shown at all. After that, any further items to be labelled are considered from highest to lowest priority on a "first come, first served" basis, meaning that the next item will be considered and if a label position having a cost that is smaller than the invisible cost is found, then that item is shown and labelled at that position; otherwise it is not shown.

A point of interest never appears without a label. This means that, if in the given labelling arrangement its label would not appear, then the point of interest is removed from the schematic. Conversely, points of interest at the start and finish locations are always shown.

Additional information

Further information can be shown on the schematic to further assist the user.

At junctions, one or more arrow symbols are added to the schematic to indicate the suggested route through the junction. If the angle between the road segment taken into the junction and that taken out of the junction when following the route is less than a certain threshold, it is considered that the instruction to be provided to the user is to walk essentially straight ahead. In this case, a single arrow is shown at the centre of the junction. If the angle exceeds the threshold, representing a turning, two arrows are drawn, one showing the way into the junction, and one showing the way out.

Examples of other additional pieces of information that can be shown include graphical indications of the current position of the sun, moon or shadows (depending on the current time of day and weather conditions) to allow the user to determine his current orientation relative to the schematic displayed on the mobile device.

Some mobile devices also include compasses, which may be used to align the schematic on the screen or to provide a graphical indication of the user's current direction.

The completed routing schematic may, depending on requirements, be augmented with text descriptions, including directions expressed as text and the distance and journey time remaining.

It will be understood that the present invention has been described above purely by way of example, and modifications of detail can be made within the scope of the invention.

Further preferred features are described below in Annex A.

Each feature disclosed in the description, and (where appropriate) the claims and drawings may be provided independently or in any appropriate combination.

CLAIMS

1. A method of generating data representative of a geographical network, using a database containing data representative of nodes and edges connected to such nodes, the nodes and edges being representative of the geographical network, and the method comprising the steps of:
(a) selecting data from the database relating to an extended junction, which junction comprises at least one node and at least one edge, and
(b) outputting the selected data.

2. A method according to Claim 1, wherein the step of selecting data comprises:
(i) selecting from the database a node which forms part of the extended junction; and
(ii) selecting from the database in accordance with predetermined criteria at least one edge which forms part of the extended junction and which is connected to the selected node.

3. A method according to Claim 2 wherein the step of selecting data comprises selecting an edge if the length of the edge is less than a predetermined length.

4. A method according to Claim 2 wherein the step of selecting data comprises selecting an edge in accordance with a related flag in the database.

5. A method according to Claim 4 wherein the step of selecting data comprises selecting an edge in accordance with data in the database which relates the edge with another edge that has already been selected.

6. A method according to any of Claims 2 to 5 wherein the step of selecting data comprises selecting an edge if the edge is an element of a road artefact such as a roundabout, dual carriageway or traffic island.

7. A method according to Claim 6 wherein the step of selecting data further comprises analysing the network adjacent to an edge to determine whether the edge is an element of a road artefact.

8. A method according to any of the preceding claims wherein the step of selecting data further comprises the step of selecting at least one node connected to any of the selected edges.

9. A method according to any of the preceding claims wherein the step of selecting data further comprises the step of selecting at least one edge connected to but not forming part of the extended junction.

10. A method according to any of the preceding claims, wherein the step of outputting the selected data comprises transmitting the selected data to a client device.

11. A method according to any of the preceding claims, further comprising the step of displaying the selected data on a handheld device, preferably in the form of a schematic.

12. A method according to any of Claims 2 to 11 further comprising selecting further data relating to a further extended junction by selecting a further node in the database, and identifying one or more further edges connected to the selected node and meeting the same or further predetermined criteria, and further outputting the further data relating to the further extended junction.

13. A method of processing data representative of a geographical network, which network is formed from nodes connected by edges, the method comprising selecting an edge, analysing the portion of the network adjacent to the selected edge to determine whether the edge is an element of an artefact; and processing the selected edge in dependence on the result of the analysis.

14. A method according to Claim 13 wherein the step of analysis comprises determining whether the configuration of the portion of the network adjacent to the selected edge satisfies predetermined criteria.

15. A method according to Claim 13 or 14 wherein the network is a road network, and the step of analysing the network comprises determining whether the edge forms part of a traffic island.

16. A method according to any of the preceding claims, further comprising processing the set of selected nodes and edges in accordance with a modification algorithm.

17. A method of processing data representative of a geographical network, the method comprising the steps of:

a) retrieving the data from a database;
b) processing the data in accordance with a modification algorithm; and
c) outputting the processed data.

18. A method according to Claim 16 or 17 wherein the modification algorithm geometrically simplifies the data.

19. A method according to any of Claims 16 to 18 wherein the data includes a plurality of nodes, and the modification algorithm adjusts the relative positions of the nodes.

20. A method according to any of Claims 16 to 19 wherein the data includes a plurality of edges, and the modification algorithm adjusts the relative angles between at least two such edges.

21. A method according to Claim 20 wherein the modification algorithm snaps the relative angles of at least two edges to one of a set of preferred angles.

22. A method according to Claim 20 or 21 wherein the modification algorithm adjusts the relative angles of at least two edges to be parallel or anti-parallel.

23. A method according to any of Claims 16 to 22 wherein the modification algorithm includes the steps of:

a) identifying preferable alignment relationships between different elements of the data; and

b) adjusting the relative positions of the elements so as to provide an arrangement which best satisfies the identified alignment relationships.

24. A method according to Claim 23, the data including at least one node and at least one edge connected to the node(s) and being representative of at least one junction exit, and wherein the modification algorithm includes the steps of identifying at least one edge as a junction exit; identifying preferable alignment relationships between the or each junction exit; and adjusting the relative positions and/or angles of the junction exits so as to provide an arrangement which best satisfies the identified alignment relationships.

25. A method according to Claim 23 or 24, further comprising computing a measure of the strength of the alignment relationships in dependence on the similarity of the geometry of the elements to a predetermined relationship, such as a parallel or anti-parallel relationship.

26. A method according to any of Claims 16 to 25, the data including at least one node and at least one edge connected to the node(s), and wherein the modification algorithm preserves anti-parallel relationships between pairs of edges in preference to parallel relationships between pairs of edges.

27. A method according to any of Claims 16 to 26, the data including at least one node and at least one edge connected to the node(s), and wherein the modification algorithm includes the steps of identifying one or more of said edges as junction exits; and grouping the junction exits into clumps of junction exits which can be displayed as emanating from the same point.

28. A method according to Claim 27 wherein the modification algorithm attempts to minimise the numbers of clumps in the graphical schematic.

29. A method according to any of Claims 16 to 28 the data including at least one node and at least one edge connected to the node(s), and wherein the modification algorithm includes the steps of:

a) identifying one or more of said edges as junction exits;

b) determining the angle of each of the junction exit(s); and

c) modifying the data in accordance with the angle(s) of the junction exit(s).

30. A method according to Claim 29 wherein the junction exit is defined by a series of polyline segments at different angles, and the angle of the junction exit is determined by analysing the polyline segments to determine a representative angle.

31. A method according to Claim 30 wherein the modification algorithm aligns the graphical data with a selected screen geometry.

32. A method of providing a graphical schematic of a location, the method comprising the steps of:

a) selecting one or more of points of interest from a database in accordance with a predetermined selection algorithm;

b) generating a graphical schematic including the selected points of interest; and

c) outputting the graphical schematic generated in step b).

33. A method according to Claim 32 wherein the algorithm includes the steps of:

a) ranking a plurality of points of interest; and

b) selecting one or more of the points of interest in accordance with their rank.

34. A method according to Claim 32 or 33 wherein the algorithm includes the steps of:

a) retrieving one or more stored parameters associated with each point of interest; and

b) selecting one or more of the points of interest in accordance with their associated stored parameter(s).

35. A method according to any of Claims 32 to 34 wherein the selection algorithm comprises the steps of:

a) selecting a location; and

b) selecting one or more points of interest within a predetermined radius of the selected location.

36. A method according to any of Claims 32 to 35 wherein the database includes a plurality of nodes and the selection algorithm includes the step of:

a) selecting a node;

b) defining a region surrounding the node; and

c) selecting points of interest within the defined region.

37. A method according to Claim 36 wherein the step of defining a region surrounding the node comprises defining a circular region centred on the node.

38. A method according to any of Claims 32 to 37 wherein the selection algorithm selects one or more of points of interest from the database in accordance with the visibility of the points of interest.

39. A method according to any of Claims 32 to 38 wherein the selection algorithm selects one or more of points of interest from the database in accordance with the time of day.

40. A method according to any of Claims 32 to 39 further comprising storing a list of favourite points of interest associated with a particular user, wherein the selection algorithm preferentially selects points of interest stored in the list.

41. A method according to any of Claims 32 to 40 further comprising the steps of:

a) calculating a direction; and

b) outputting data which indicates the direction calculated in step a).

42. A method of providing a graphical schematic of a location, the method comprising the steps of:

a) calculating a direction;

b) generating a graphic schematic including information which indicates the direction calculated in step a); and

c) outputting the graphical route schematic.

43. A method according to Claim 41 or 42 wherein the information comprises a marker.

44. A method according to Claim 43 wherein the marker comprises an arrow.

45. A method according to any of Claims 42 to 44 wherein the graphical schematic includes a junction including a incoming road segment taken into the junction and a outgoing road segment taken out of the junction, and wherein the method includes the step of determining the angle between the incoming and outgoing road segments and selecting the information in step b) in accordance with the angle.

46. A method according to Claim 44 and 45 wherein the number of arrows included in the graphical schematic varies in accordance with the angle.

47. A method according to any of the preceding claims further comprising the steps of:

a) determining the current position of the moon or sun; and

b) outputting data which indicates the current position of the moon or sun determined in step a).

48. A method of providing a graphical schematic of a location, the method comprising the steps of:

a) determining the current position of the moon or sun;

b) generating a graphical schematic of the location, the schematic including information which indicates the current position of the moon or sun determined in step a); and

c) outputting the schematic generated in step b).

49. A method according to Claim 47 or 48 wherein the information comprises a marker.

50. A method according to Claim 49 wherein the position of the marker within the schematic is dependent on the current position of the moon or sun.

51. A method according to Claim 49 or 50 wherein the marker comprises a shadow image, the configuration of the shadow image being dependent on the current position of the moon or sun.

52. A method according to any of the preceding claims further comprising the steps of:

a) receiving configuration data; and

b) generating the graphical schematic in accordance with the configuration data received in step a)

53. A method of providing graphical schematic data, the method comprising the steps of:

a) receiving configuration data;

b) generating a graphical schematic in accordance with the configuration data received in step a); and

c) outputting the graphical schematic generated in step b).

54. A method according to Claim 52 or 53 wherein the schematic is output to a device, and wherein the configuration data is indicative of a property of the device.

55. A method according to Claim 54 wherein the property is the screen resolution of the device.

56. A method according to any of Claims 52 to 55 wherein the configuration data is indicative of a user preference.

57. A method according to any of the preceding claims further comprising:

a) selecting a network element from a database;

b) selecting a point of interest from a database in accordance with a predetermined selection algorithm;

c) determining a geometrical relationship between the network element selected in step a) and the point of interest selected in step b);

d) generating an abstract representation of the point of interest in accordance with the geometrical relationship determined in step c);

e) generating a graphical schematic including the set of network elements selected in step a) and the abstract representation of the point of interest generated in step d); and

f) outputting the graphical schematic.

58. A method of providing a graphical schematic of a location, the method comprising the steps of:

a) selecting a network element from a database;

b) selecting a point of interest from a database in accordance with a predetermined selection algorithm;

c) determining a geometrical relationship between the network element selected in step a) and the point of interest selected in step b);

d) generating an abstract representation of the point of interest in accordance with the geometrical relationship determined in step c);

e) generating a graphical schematic including the set of network elements selected in step a) and the abstract representation of the point of interest generated in step d); and

f) outputting the graphical schematic.

59. A method according to Claim 57 or 58 wherein the geometrical relationship relates to the visibility of the point of interest from the edge.

60. A method according to any of Claim 57 to 59, wherein the geometrical relationship relates to the apparent size of the point of interest from the edge.

61. A method according to any of Claims 57 to 60, wherein the geometrical relationship relates to the distance of the point of interest from the edge.

62. A method according to any of Claims 57 to 61 wherein the abstract representation of the point of interest comprises an abstract frontage of the point of interest, directed towards the edge.

63. A method of providing a graphical schematic of a location bounded by a defined geographical area, the method comprising the steps of:

a) selecting one or more of points of interest falling outside the defined geographical area from the database;

b) generating a graphical schematic of the defined geographical area, the graphical schematic including an indication of the direction of the point(s) of interest falling outside the defined geographical area; and

c) outputting the graphical schematic generated in step b).

64. A method according to Claim 63 wherein the graphical schematic also includes an indication of the distance to the point(s) of interest falling outside the defined geographical area.

65. A method according to any of the preceding claims wherein the graphical schematic includes first source data from a first source and second source data from a second source.

66. A method of providing a graphical schematic, the method comprising the steps of:

a) obtaining first source data from a first data source;

b) obtaining second source data from a second data source;

c) generating a graphical schematic including said first source data and said second source data; and

d) outputting said graphical schematic generated in step c).

67. A method according to Claim 65 or 66 including the steps of:

a) identifying a first feature in the first data source;

b) identifying a second feature in the second data source;

c) determining whether the second feature overlaps with the first feature; and

d) associating the second feature with the first feature if the second feature overlaps with the first feature.

68. A method according to any of the preceding claims wherein the schematic is generated and output from a central server; the method including receiving and displaying the schematic at a mobile client device.

69. A system for performing the method of Claim 68, the system comprising a central server configured to generate and output schematics to a mobile client device; and a mobile client device configured to receive and display the schematics.

70. Apparatus for generating data representative of a geographical network, using a database containing data representative of nodes and edges connected to such nodes, the nodes and edges being representative of the geographical network, and the apparatus comprising:

(a) means for selecting data from the database relating to an extended junction, which junction comprises at least one node and at least one edge, and

(b) means for outputting the selected data.

71. Apparatus for processing data representative of a geographical network, the apparatus comprising:

a) means for retrieving the data from a database;

b) means for processing the data in accordance with a modification algorithm; and

c) means for outputting the processed data.

72. Apparatus for providing a graphical schematic of a location, the apparatus comprising:

a) means for selecting one or more of points of interest from a database in accordance with a predetermined selection algorithm;

b) means for generating a graphical schematic including the selected points of interest; and

c) means for outputting the graphical schematic.

73. A method substantially as described herein with reference to any of Figures 1 to 30B of the drawings.

74. Apparatus substantially as described herein with reference to any of Figures 1 to 3, 18a, 18b and 18c of the drawings.

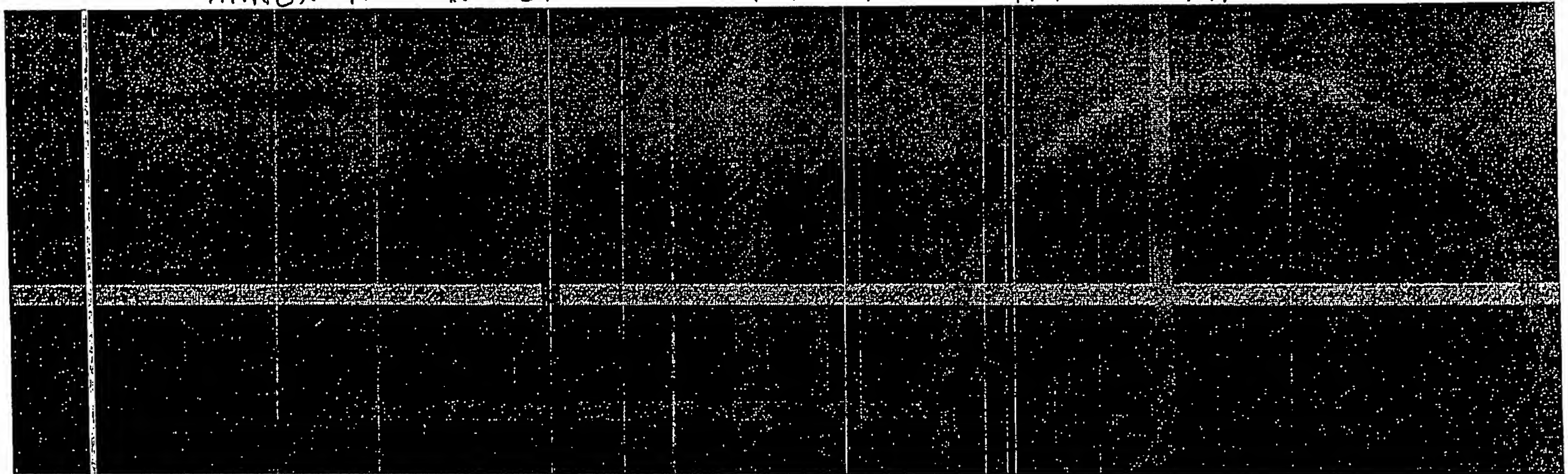
ABSTRACT

SCHEMATIC GENERATION

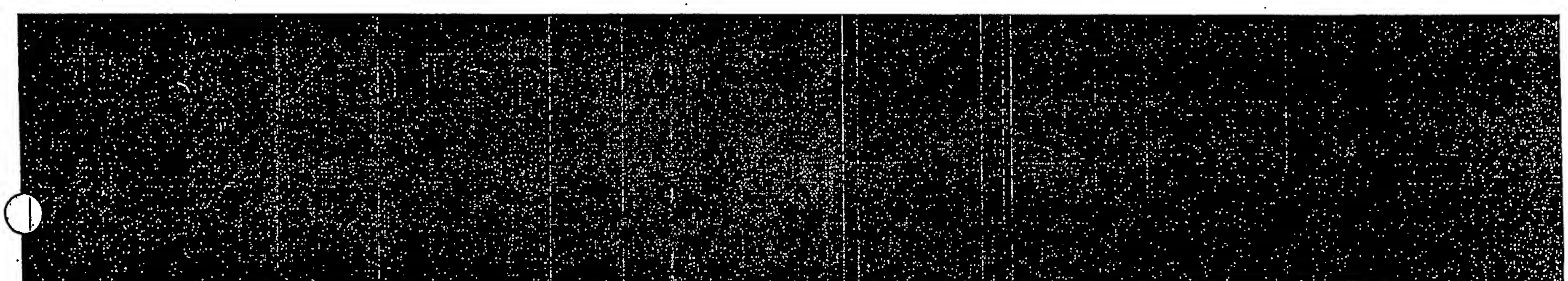
A method of generating data representative of a geographical network (such as a road network) is disclosed, comprising steps of selecting from a database (2) data relating to an extended junction (formed from at least one node and at least one edge) and outputting the selected data. The method addresses problems in existing devices relating to the selection of appropriate data, and finds particular application in the field of mobile devices and the like. Apparatus for generating data representative of a geographical network and a method of providing a graphical schematic of a location are also disclosed.

(Figure 1)

ANNEX A: ANNEX FORMING PART OF PATENT APPLICATION (1)

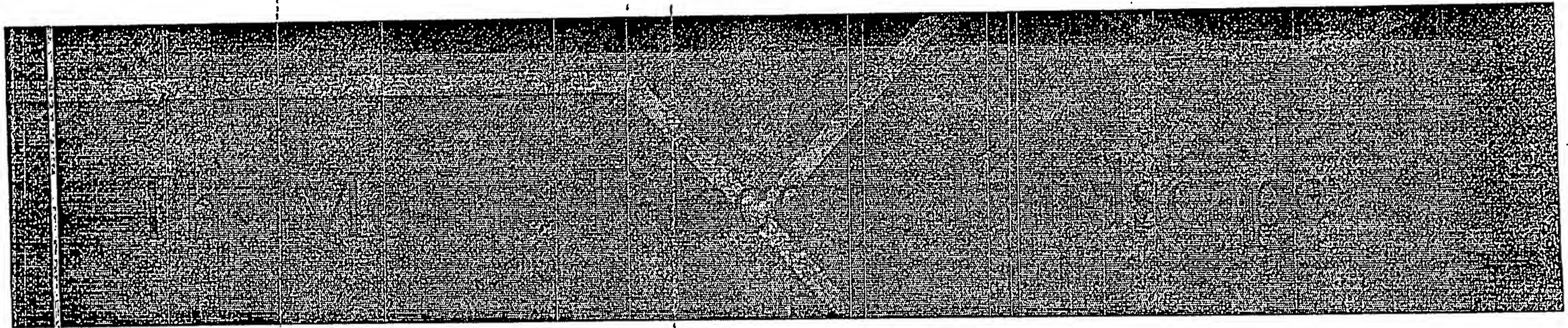


m spatial



- Introduction to m-spatial
- The mobile telecoms landscape
- Barriers to adoption for new services
- The concept of "where?"
- m-spatial's role
- Routing and Guidance
- What's special about m-spatial?

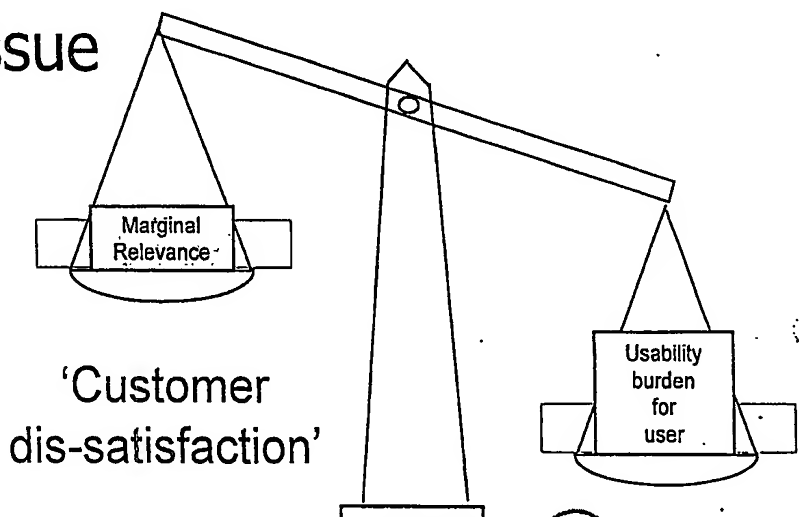
- Founded June 2001
- First round funding £1.2m
  - 3 prominent Venture Capitalists
    - Prelude, Alta-Berkeley, Delta Partners
- Strong management team from GIS and Telecoms Industries
  - Jon Billing and Adrian Cuthbert – Laser-Scan
  - Andy Walker - Vocalis



- Many markets reaching saturation
  - Emphasis is now more on:
    - Customer retention
    - Revenue per customer
- New Value added services are now key
  - Ultimately 3G...
  - ...but lots of potential with 2G and 2.5G
  - Extended use of SMS is gaining ground
  - Location based services (LBS) are a prime candidate

m spatial

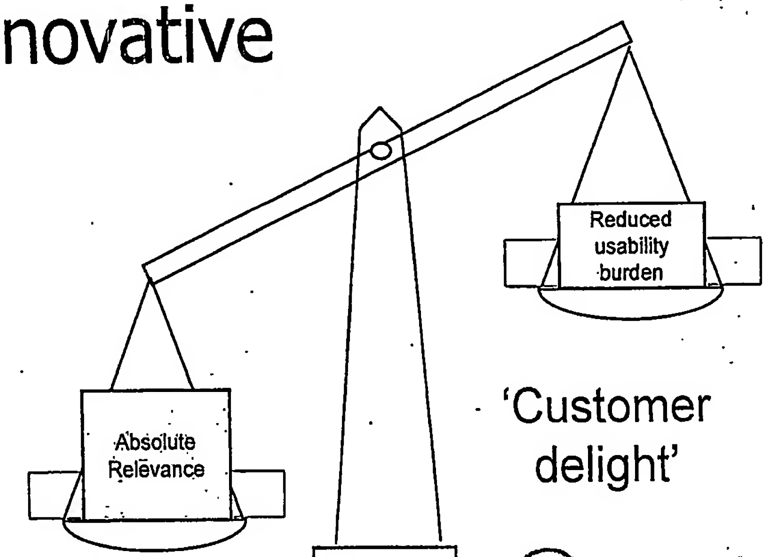
- Mobile Internet concept is facing significant challenges
  - Services must be relevant to the mobile context
    - Many of the initial services have simply provided access to a fixed internet site from a mobile terminal
  - Usability is a significant issue
    - WAP can be a poor user experience



'Customer dis-satisfaction'

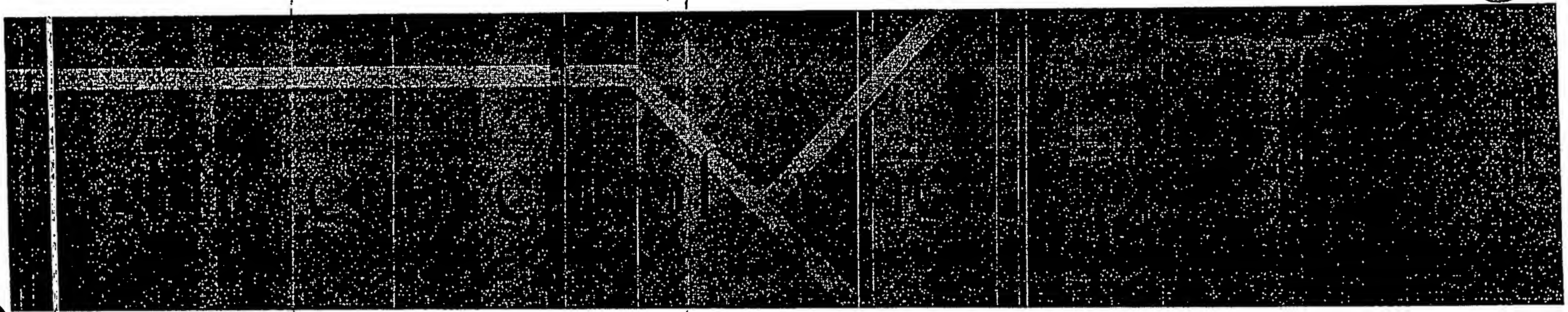
m spatial

- Services including the concept of "where?" can offer much improved relevance
  - Users often need to know the answer to this question 'on the street'
- Usability issue requires innovative technology to address:
  - Limited user input
  - Restricted display



'Customer delight'

m spatial



- The need to know "where?" is a basic human need
  - Where to meet socially, for business, where to buy things…the list goes on
- There are some content rich LBS – but text based usability is poor
- The answer to the question "where?" is often best expressed graphically
  - We've all scribbled maps on the back of an envelope

"Providing a uniquely usable answer to the question 'where?' on mass market mobile devices"

Answers to the question

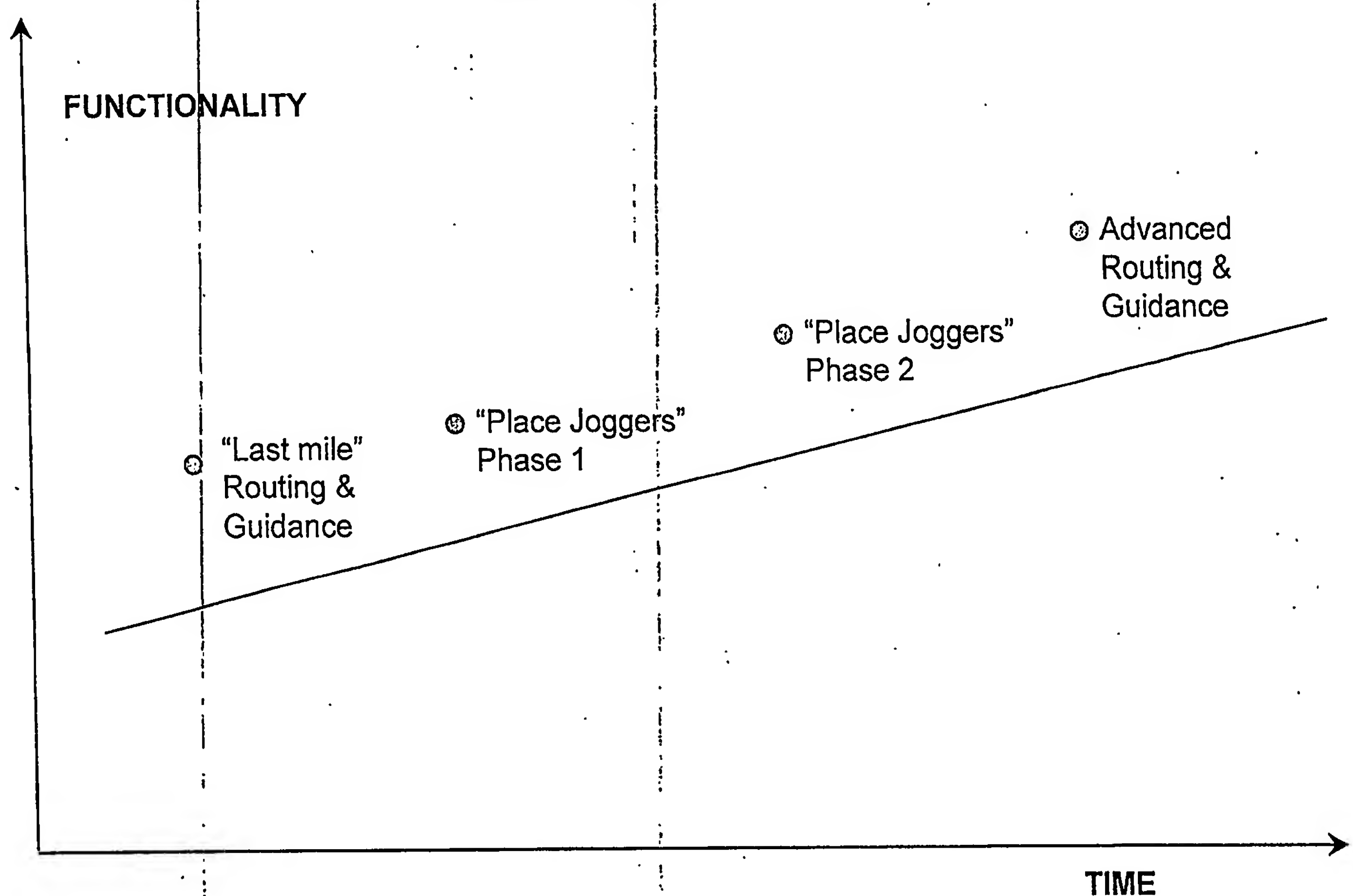
- The name of the location might be enough
  - e.g. The Red Lion
- Many people might require a memory jogger
  - e.g. The Red Lion is 5 mins walk from Cockfosters tube station
  - A map of the immediate surrounding area
- A further group would require full directions
  - Step by step routing and guidance must be provided

m spatial

- To provide a representation of "where?" suitable for the input and output capabilities of a mass market device
  - Simply delivering a map segment to small device is not usable

"m-spatial's proprietary technology dynamically produces sketch maps customised to the area and/or route being displayed and the device being used"

(11)

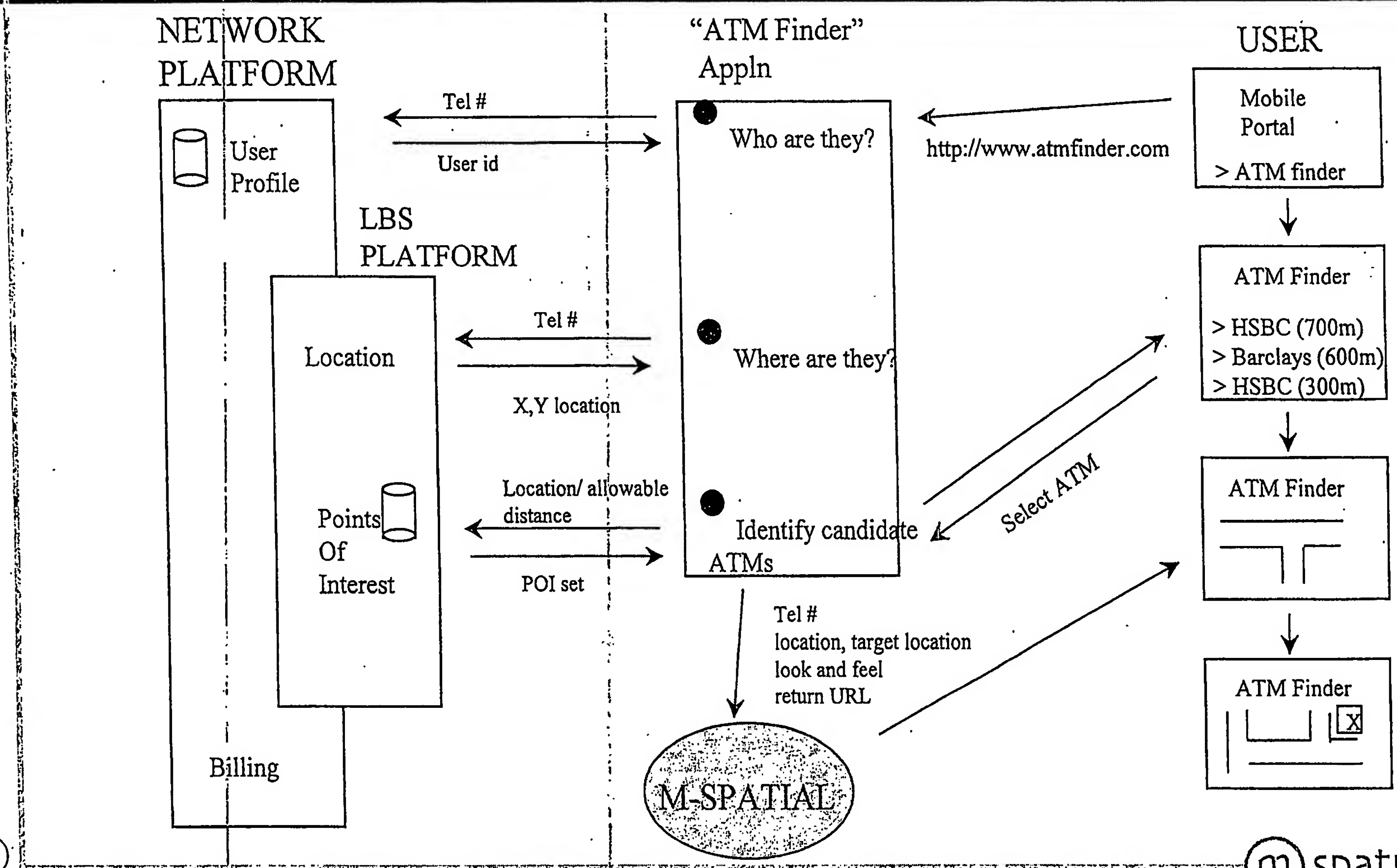

FUNCTIONALITY
"Last mile" Routing & Guidance
"Place Joggers" Phase 1
"Place Joggers" Phase 2
Advanced Routing & Guidance
TIME

m spatial

- A component technology that can be used by applications to represent the answer to the question "where?"
  - An individual function within the network
  - High level task oriented API
  - Managed Service – via an internet API
    - For evaluation and development
  - Onsite installation – for rollout

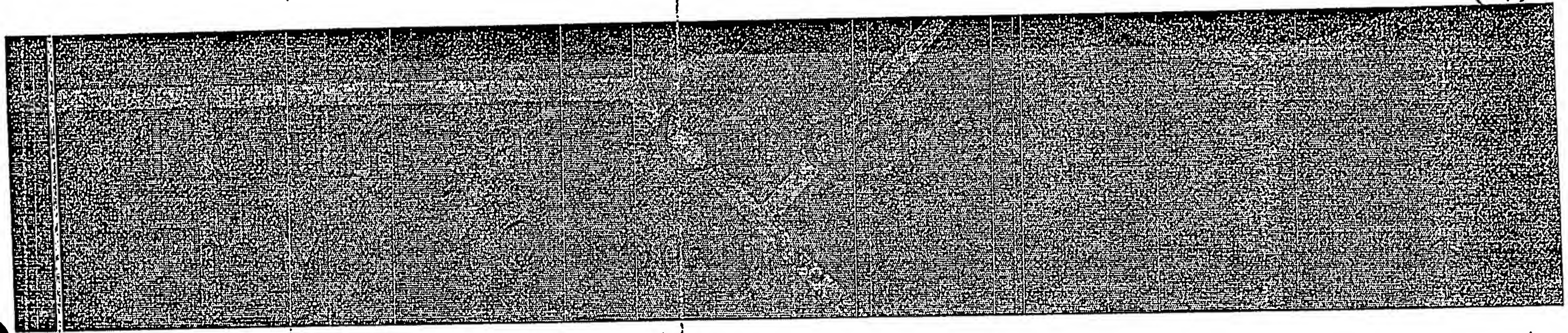
(13)

m-spatial's role



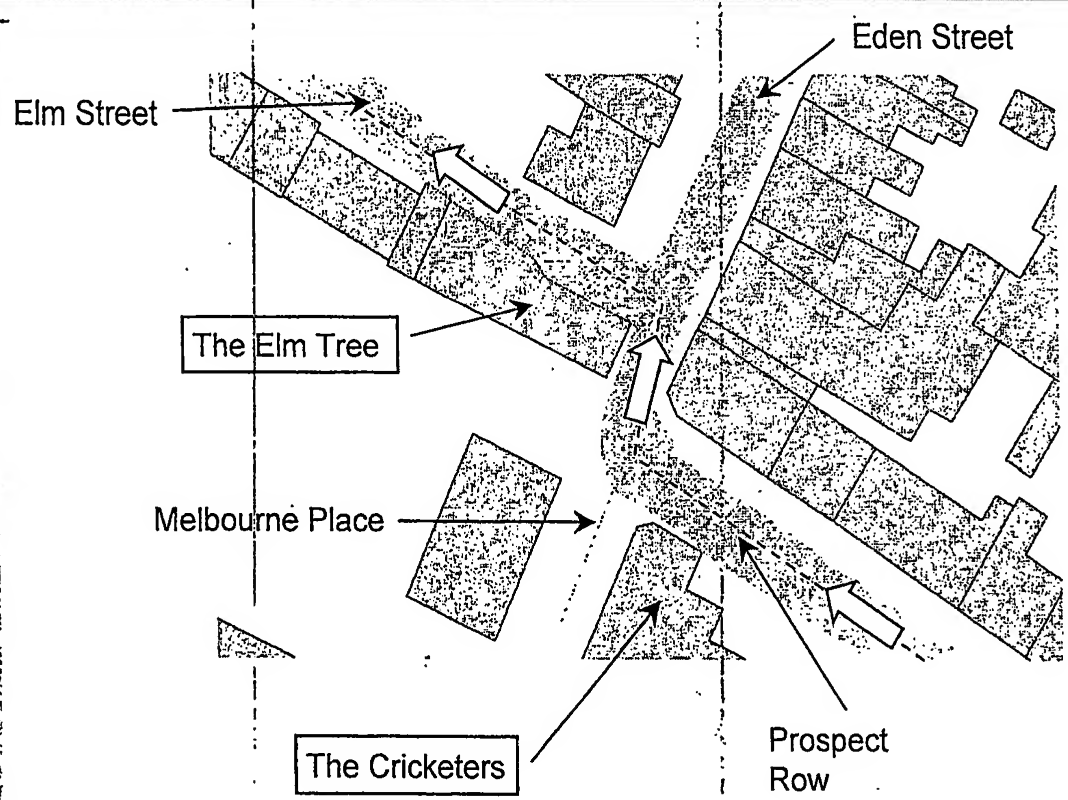
m spatial

(14)



- Many journeys involve a pedestrian "final approach"
  - User may be separated from their in-car navigation system (if they have one)
  - Could be from a tube station/a car park etc.
  - You never have a map when you need one
- The opportunity is to provide a ubiquitous usable technology that works across the spectrum of mass market mobile devices and applications

m spatial



TYPICAL TEXT DIRECTIONS

"Go 0.08 miles on Prospect Row and turn left into Elm Street"

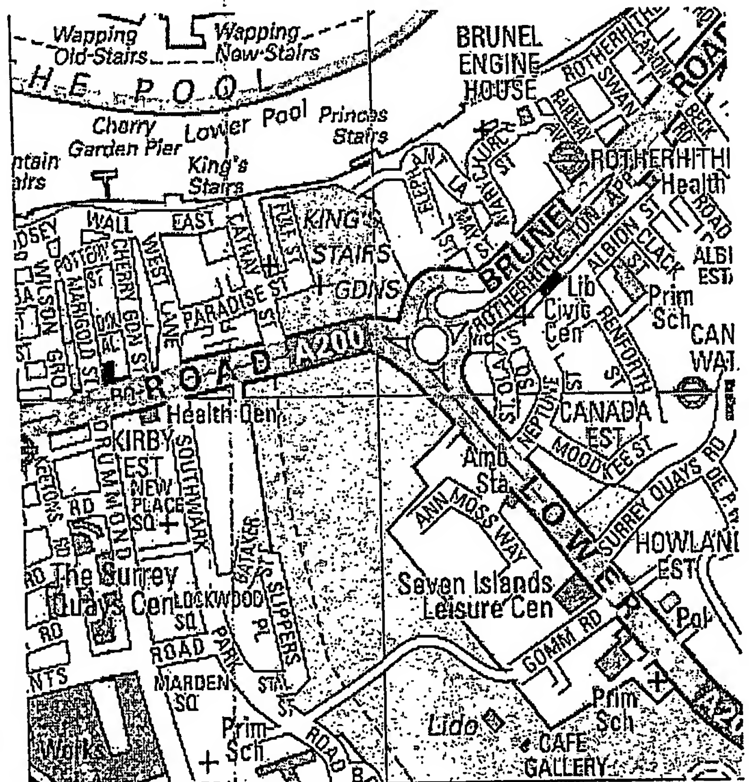
REAL WORLD ISSUES

- Have to bear right before turning left
- No road sign on entry to Elm Street
- No road sign on entry to Melbourne Place

LIKELY EFFECT

Pedestrian incorrectly chooses to walk down Melbourne Place

m spatial



Strictly Confidential

spatial

(17)

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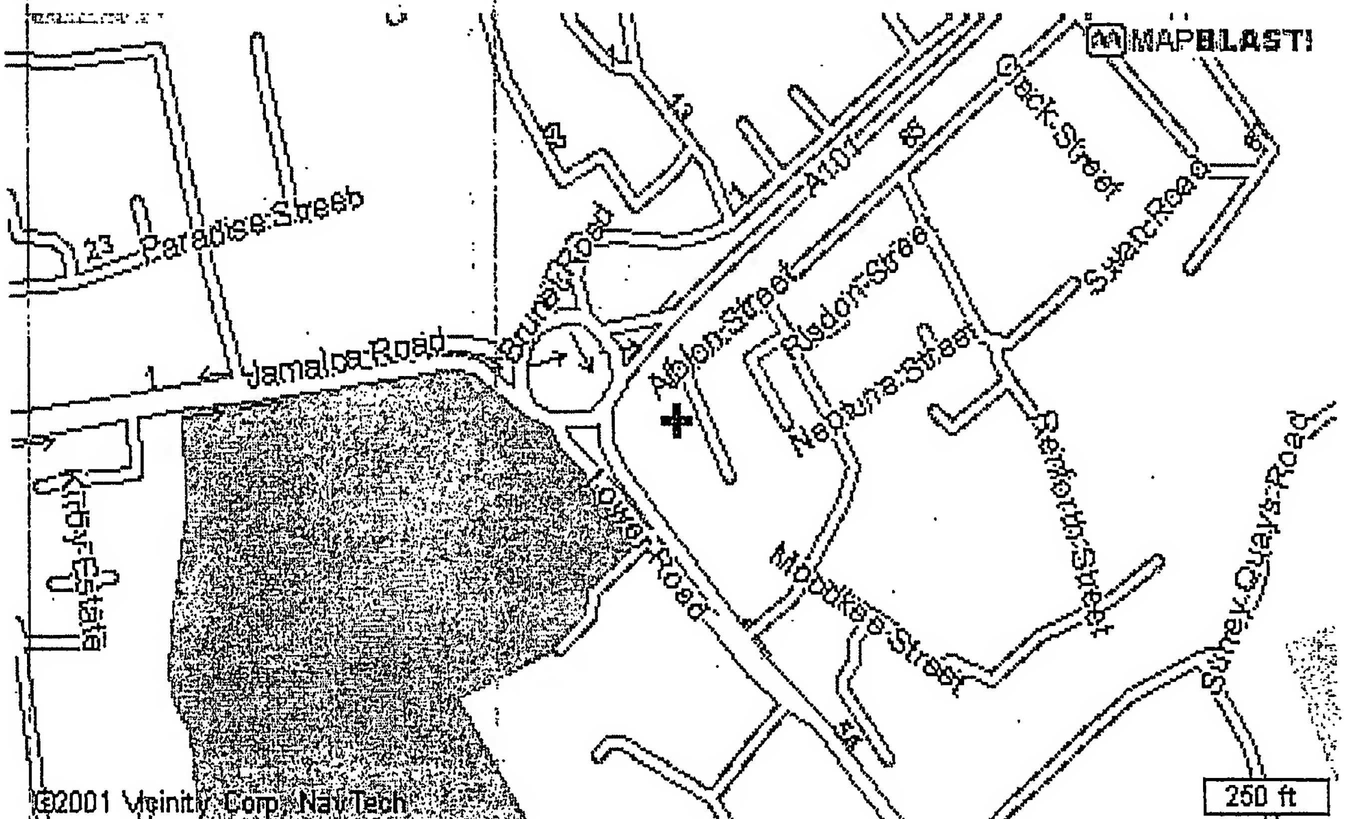
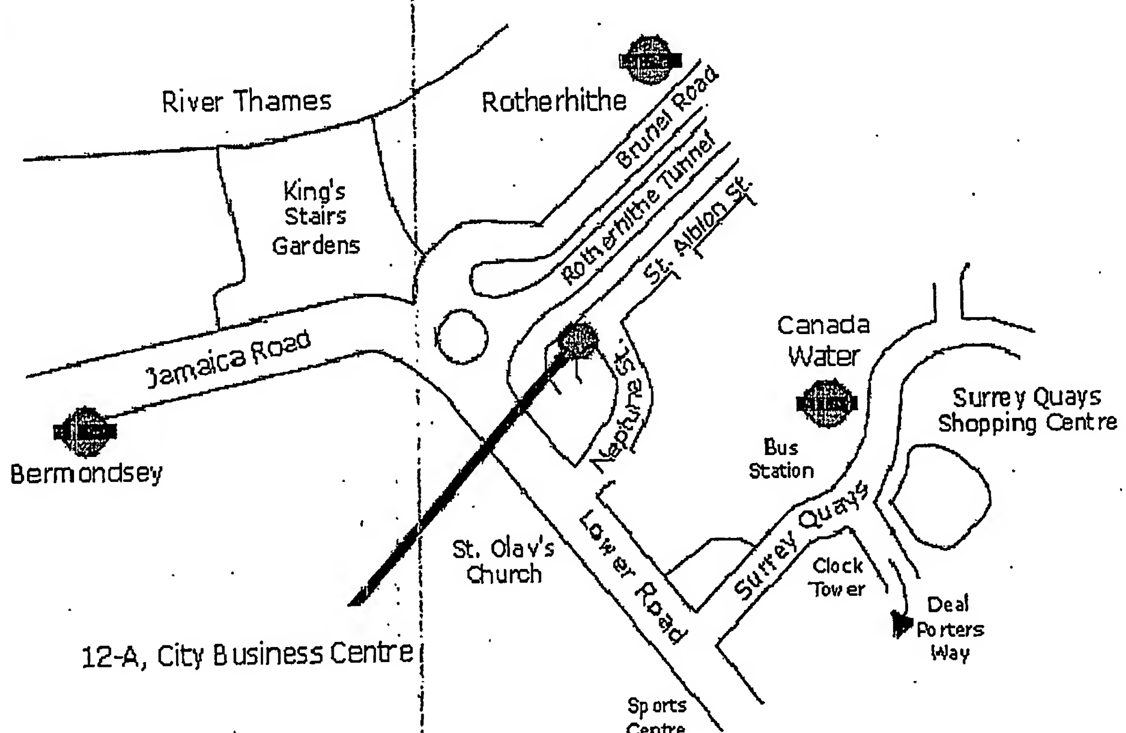


Strictly Confidential

(18)


River Thames
Rotherhithe
Brunel Road
Rotherhithe Tunnel
St. Albion St.
King's Stairs Gardens
Jamaica Road
Bermondsey
Neptune St.
Canada Water
Surrey Quays Shopping Centre
Bus Station
Surrey Quays
Clock Tower
Deal Porters Way
St. Olav's Church
Lower Road
12-A, City Business Centre
Sports Centre

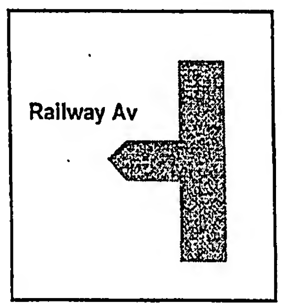
The Technology Continuum

Not Enough Detail

Confined to roads involved in junctions

"Turn left into Railway Avenue"

OR



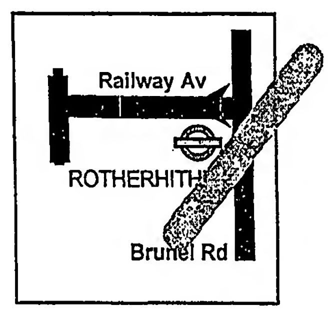
in-vehicle systems

Variable Detail

On and around the route

"Turn left into Railway Avenue just after Rotherhithe Tube Station"

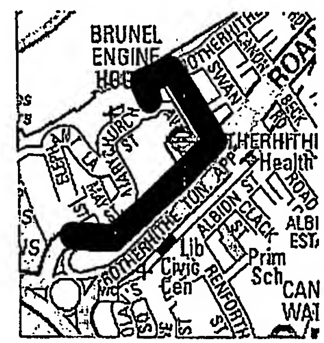
OR



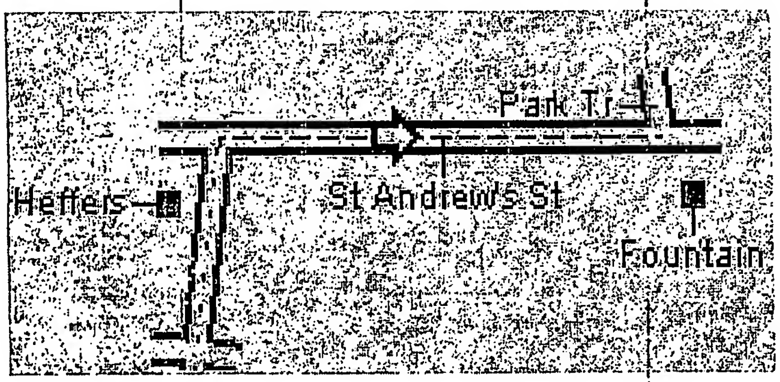
m-spatial technology

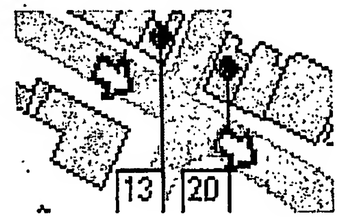
Too Much Detail

None-selective display



raster maps





<u>Larger Screen Devices</u>

Works with expected form factor for high end phones from mid 2002 (example above is R380, same approach works with squarer screens)

<u>Smaller Screen Devices</u>

Matches current phones

(21)

Routing and Guidance

- Extensive effort spent exclusively on successful delivery of directions for pedestrians on mobile phones
  - Extensive user trialing
    - Schematics work better than maps
    - Features important for display are different to in-car directions
  - Application specific back end environment
  - Significant effort in use and integration of real world positioning technologies

- Not everyone needs step by step directions
  - Given an address or name of a location, a simple map showing the destination relative to significant local landmarks may be enough
- This saves time and money for the service user
  - Lower cost than a full route
  - Just needs a single glance before the start of the final leg of the journey – no need to continually refer to it

(23)

Place [illegible]

The technical challenge

- Again an extracted map segment is not viable for a mass market phone
- The representation is best stylised
  - i.e. most often not to scale
  - Limited landmarks carefully picked to be significant and likely to be well known
  - A very limited number of roads shown – again according to likelihood of being known
  - c.f. a cut down version of a typical "how to find us" sketch map on a web site

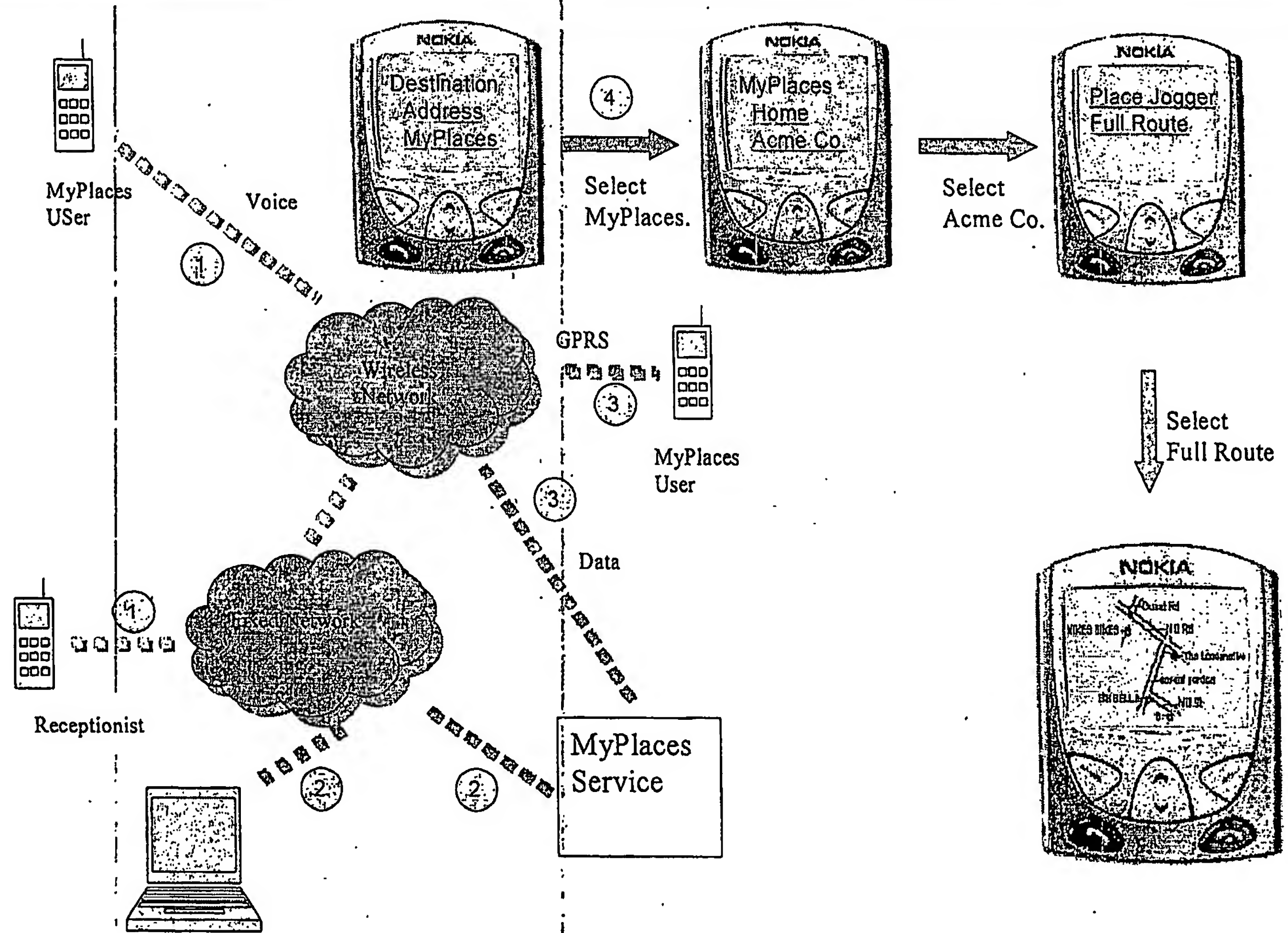
m spatial

→ Many mobile phone users aren't regularly lost – but do follow routes inefficiently due to lack of information

"The key is to make a service offering place-joggers and routing & guidance as easy to access and use as possible – and to ensure it is in the mind of the user when they might need it "

- Generally options on a major portal
  - Generic "how do I get to" application or as part of the functionality of 3rd party applications such as "Find my nearest"
- Require the user to actively access the service
- Use can be prompted externally
  - Adverts aimed at tourists or visitors to an area
    - Public transport termini, car parks etc.
- Specification of destination is most complex step

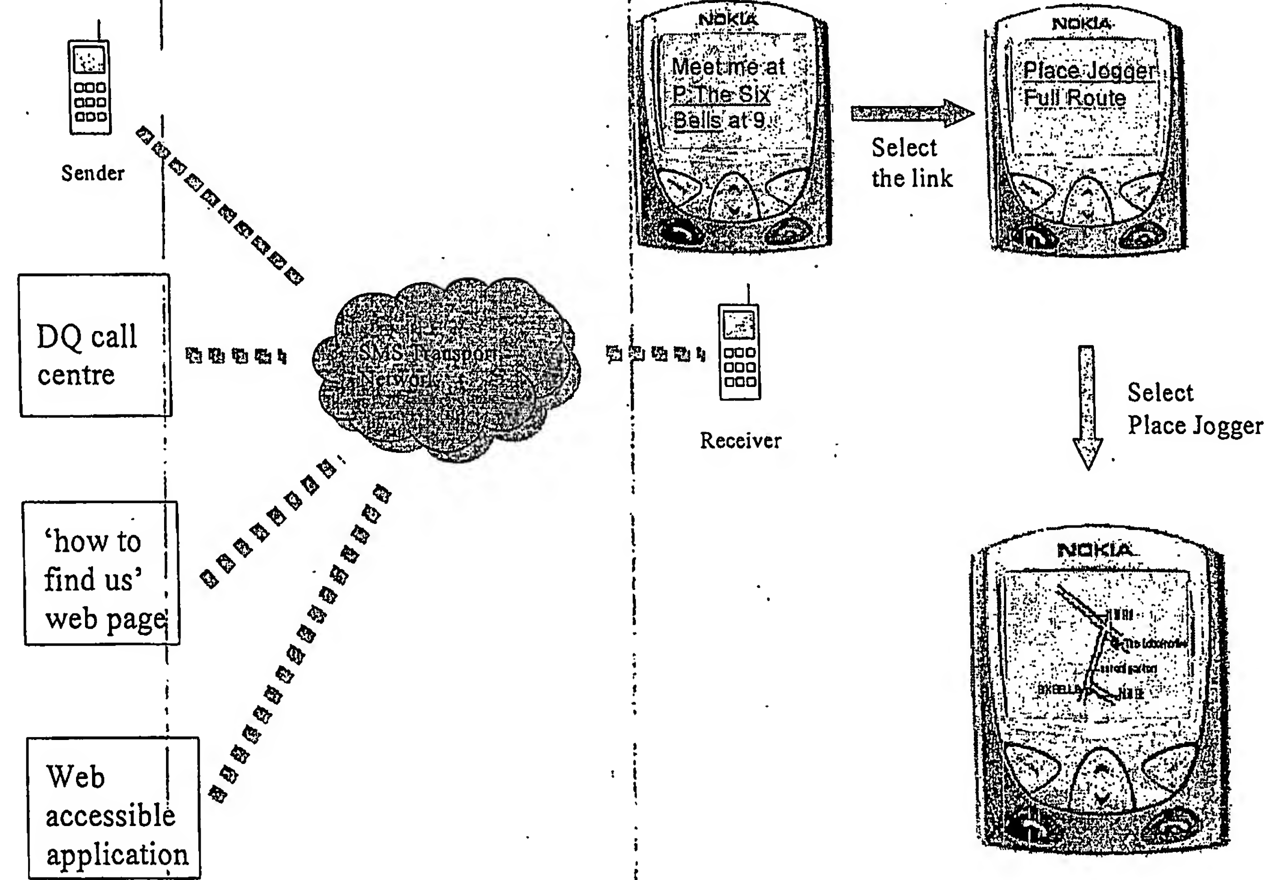
- Simplification of destination specification
  - Default mechanism is via WAP menu and text input
  - Key initial simplification is ability to pick from a pre-populated MyPlaces list
    - Entries can be generated from various sources
      - Module may be added to say a retail web site that allows the service user to enter their mobile phone number and have the retail location automatically added to their MyPlaces list
      - User or 3rd party can enter addresses/locations on a web site on the fixed internet associated with the service - for journey preparation
        - E.g. receptionist can add their office location onto the MyPlaces list of a traveling visitor who can't find their office



MyPlaces
USer
Voice
NOKIA
Destination
Address
MyPlaces
Select
MyPlaces.
MyPlaces
Home
Acme Co.
Select
Acme Co.
Place Jogger
Full Route
GPRS
MyPlaces
User
Select
Full Route
Data
Receptionist
MyPlaces
Service

m spatial

- Here the use of the service is instigated by a user for interpretation of a received 'location tag'
- Requires emergence of a standard for associating location information with entities passed by communication
  - i.e. the ability to nominate text in an SMS as having a location e.g. "The Red Lion".
  - The associated information need only be as simple as a geocode
    - The m-spatial enabled service can do the rest


Sender
DQ call centre
'how to find us' web page
Web accessible application
SMS Transport Network
Receiver
NOKIA
Meet me at P The Six Bells at 9
Select the link
NOKIA
Place Jogger
Full Route
Select Place Jogger
NOKIA

- Location tags can be complementary to the MyPlaces concept
  - But have advantage of anonymous use
    - No need to pre-register for generation of a MyPlaces list
  - 3rd party applications can deliver the location information more easily
    - E.g. Directory assistance call can deliver SMS with location tag for directory entry included along with the phone number – no need for integration to allow access to MyPlaces lists

Other benefits (I)

- Dynamic creation of sketch maps means that they can be personalised independently of lower level data
  - At the simplest level this means that a tourist guide offered by international operator can have same look and feel in London, Paris and Rome – even if data is from different sources
  - Highlighted POI priority can vary depending on application and subscriber profile
    - E.g. Shopfinder for shoe shop addict might highlight all shoe shops along a route

- Data represented may not necessarily be 'traditional geographic data'
  - E.g. 'StandFinder' application for trade shows
  - E.g. an indication on a route as to the 'safeness' of a specific area

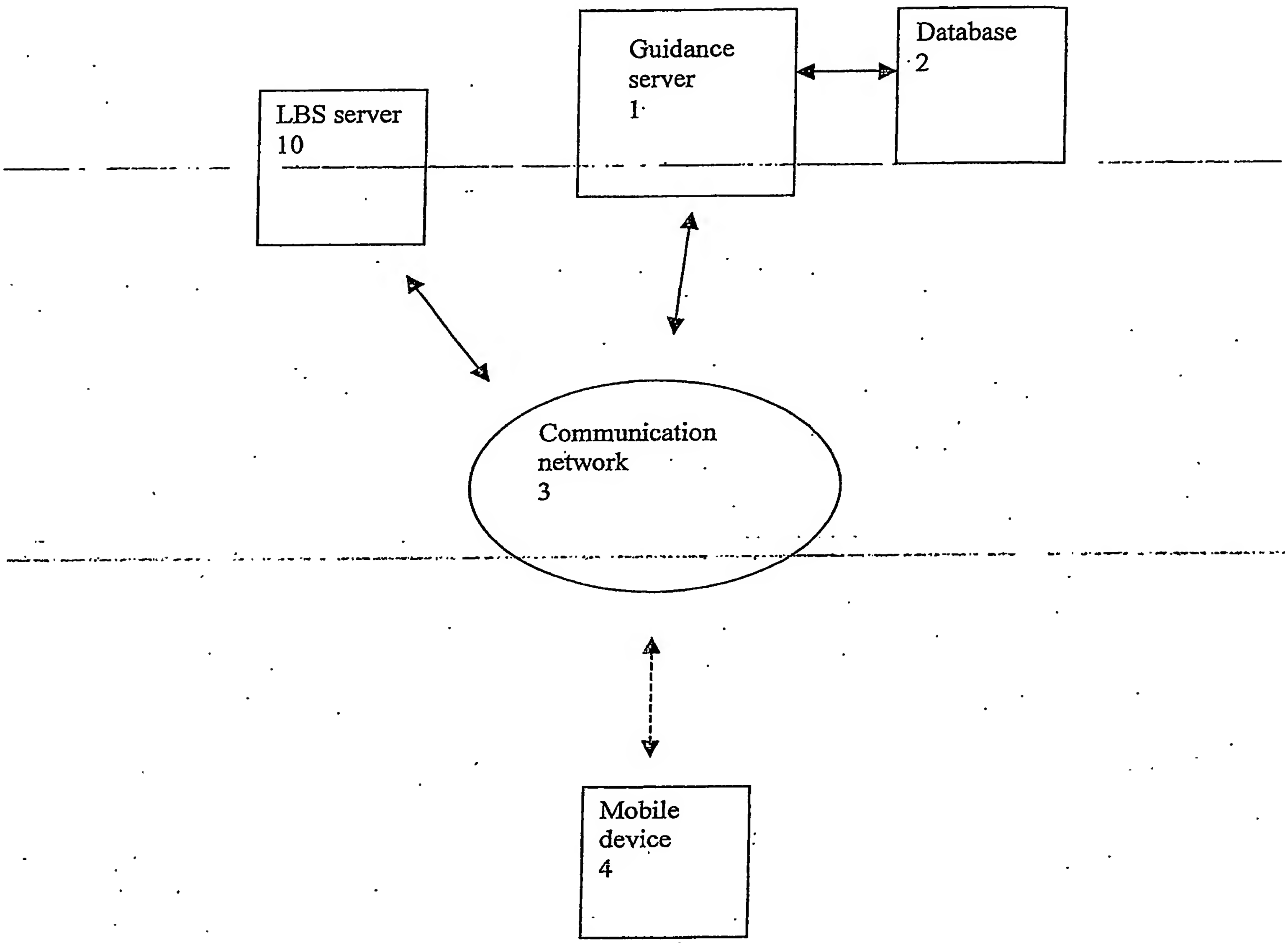

Guidance server
1
Database
2
LBS server
10
Communication network
3
Mobile device
4

Figure 1

2/15

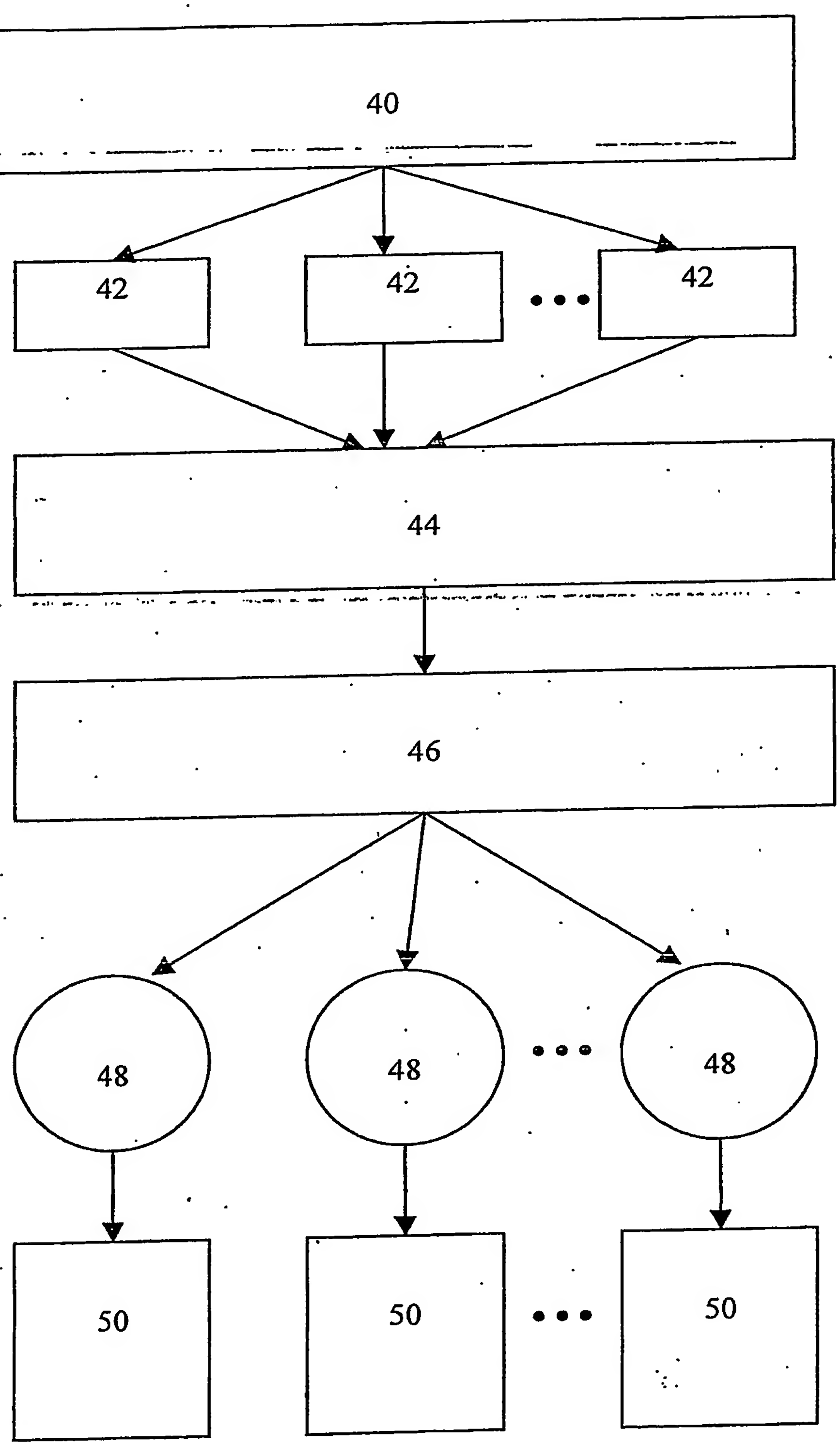


Figure 2

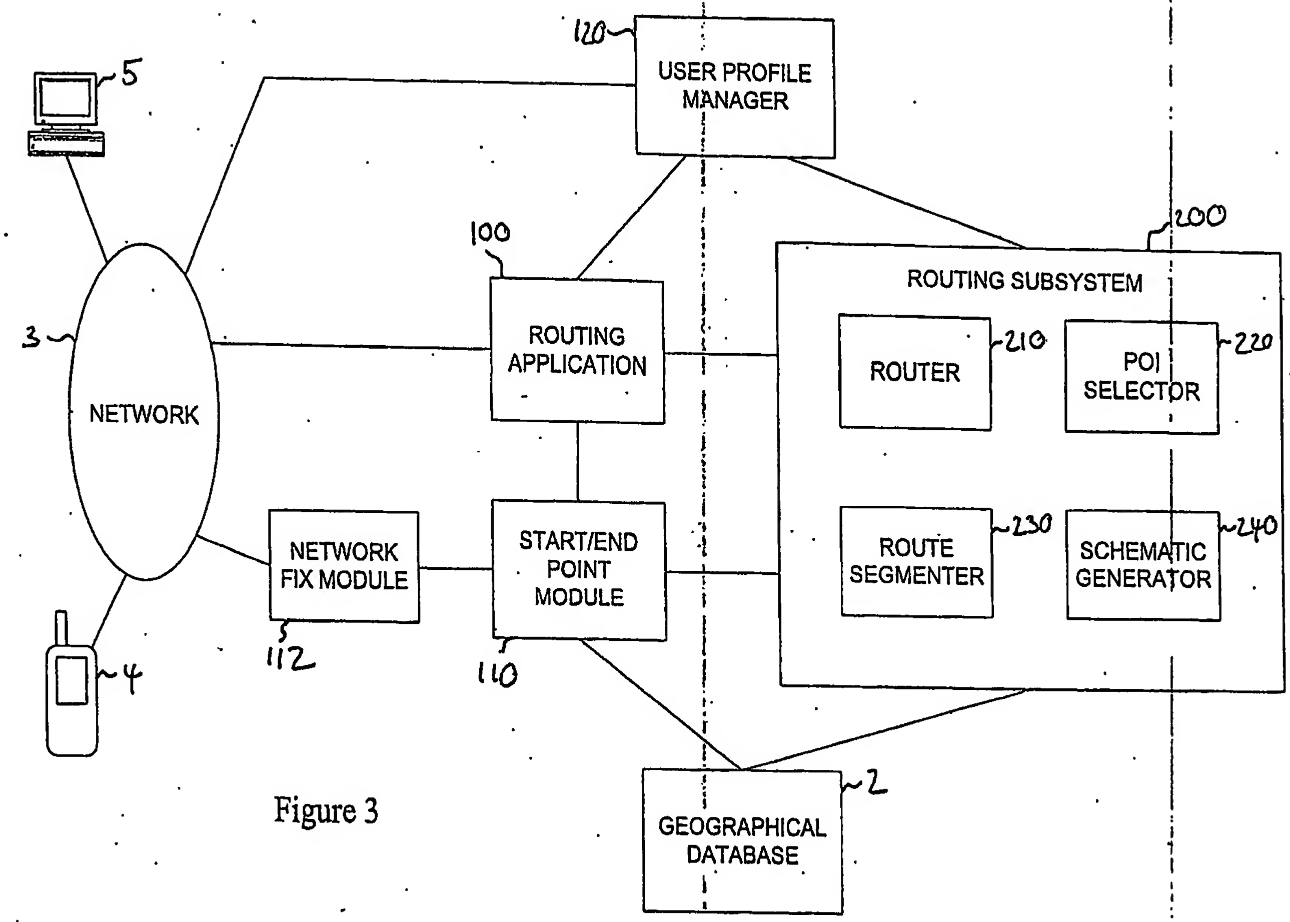

USER PROFILE MANAGER
120
5
ROUTING APPLICATION
100
ROUTING SUBSYSTEM
200
ROUTER
210
POI SELECTOR
220
3
NETWORK
NETWORK FIX MODULE
112
START/END POINT MODULE
110
ROUTE SEGMENTER
230
SCHEMATIC GENERATOR
240
4
GEOGRAPHICAL DATABASE
2

Figure 3

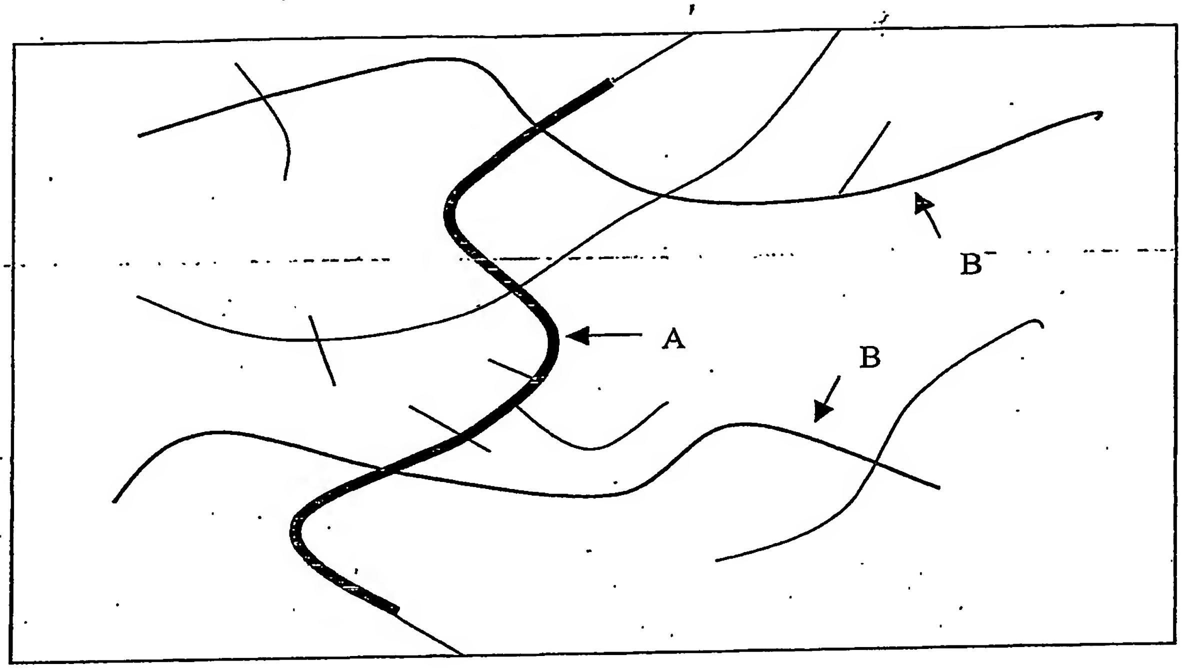


Figure 4

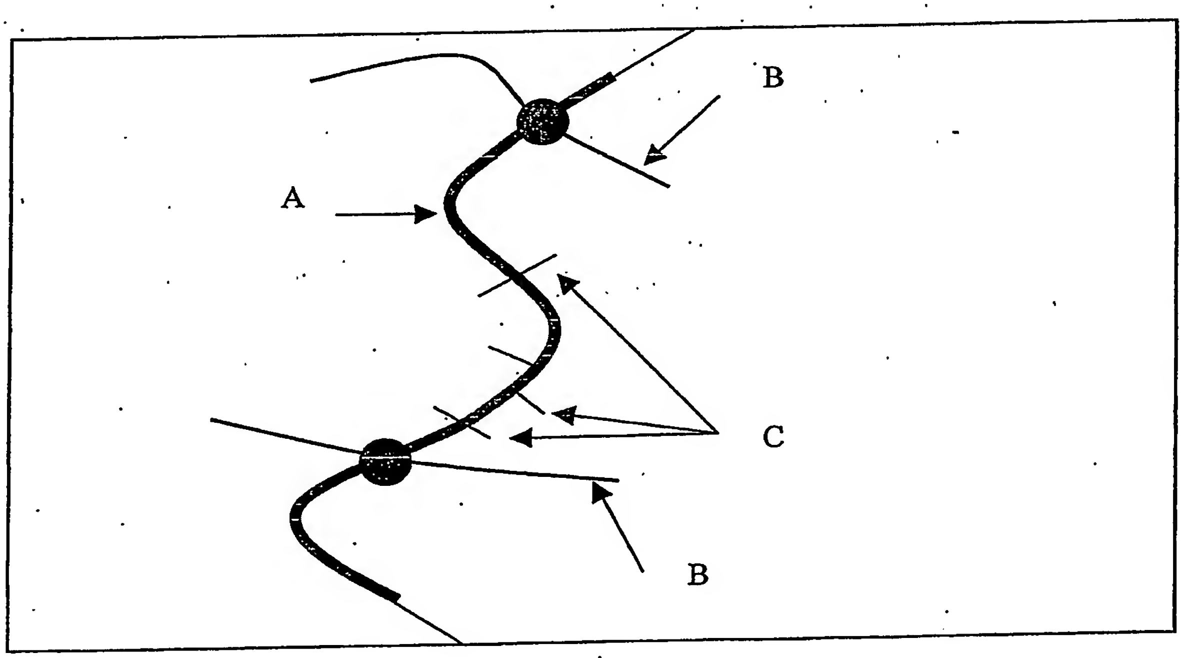


Figure 5

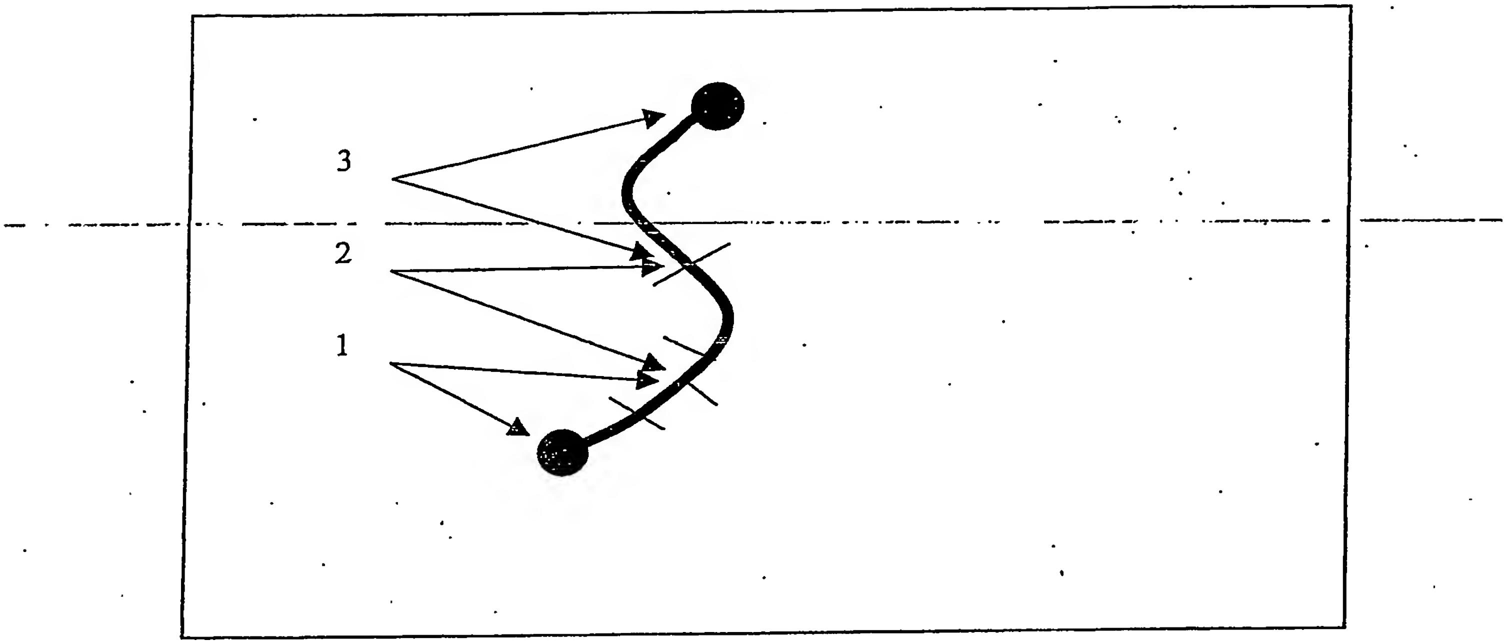


Figure 6

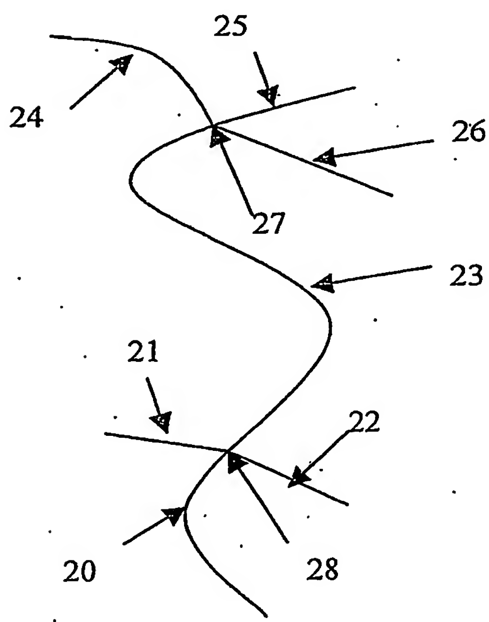


Figure 7

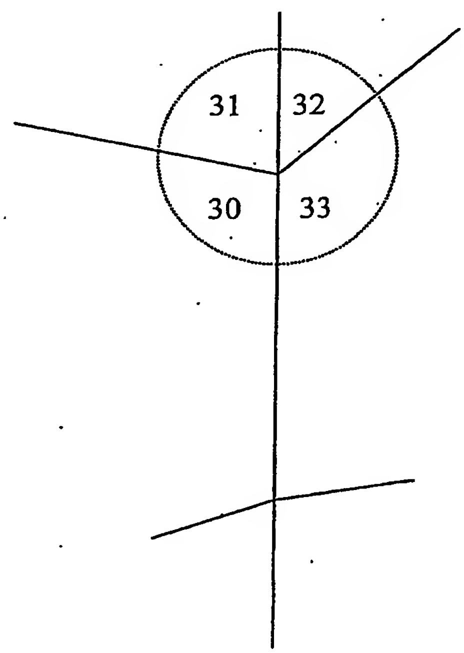


Figure 8

6/15

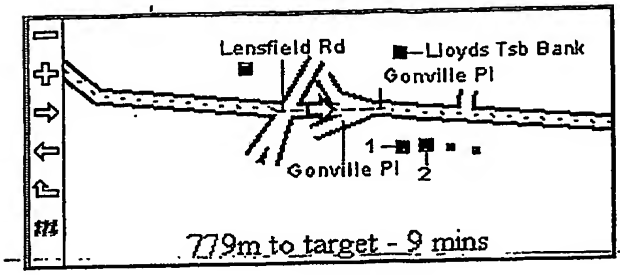


Figure 9

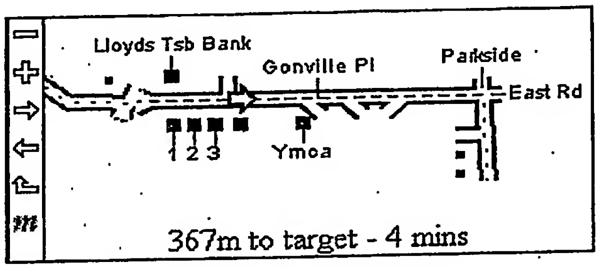


Figure 10

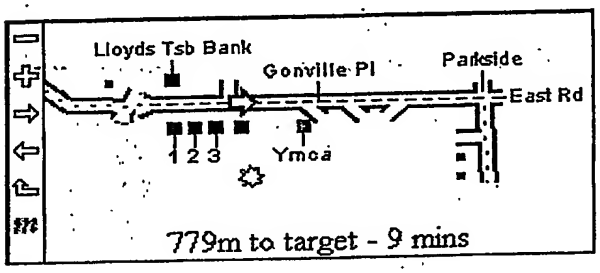


Figure 11

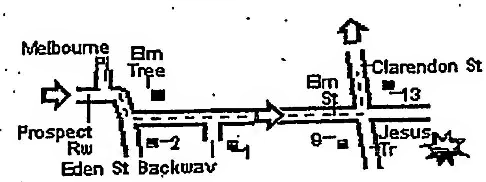


Figure 12

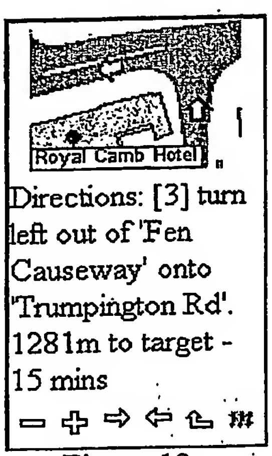


Figure 13

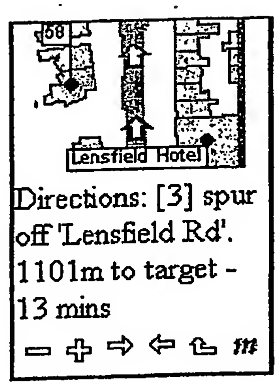


Figure 14

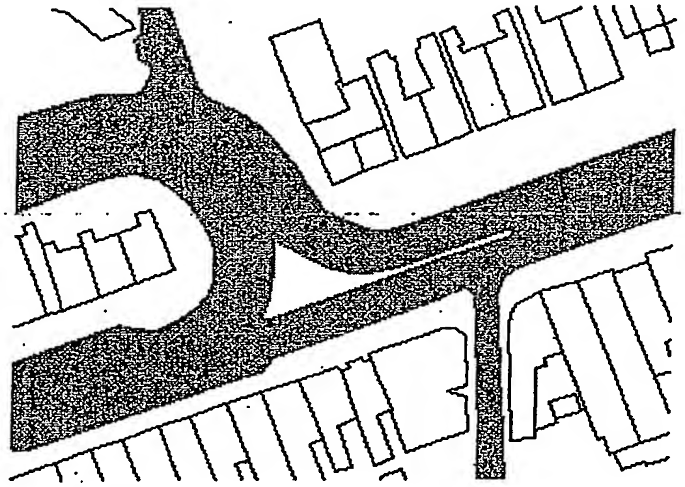


Figure 15

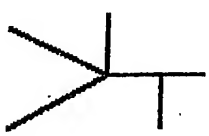


Figure 16A

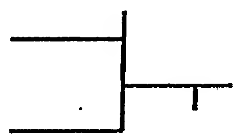


Figure 16B

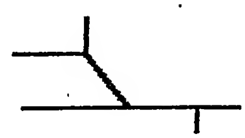


Figure 16C

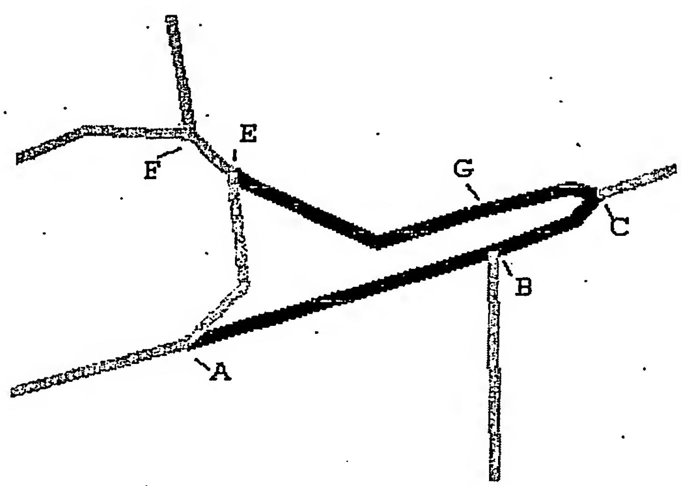


Figure 17

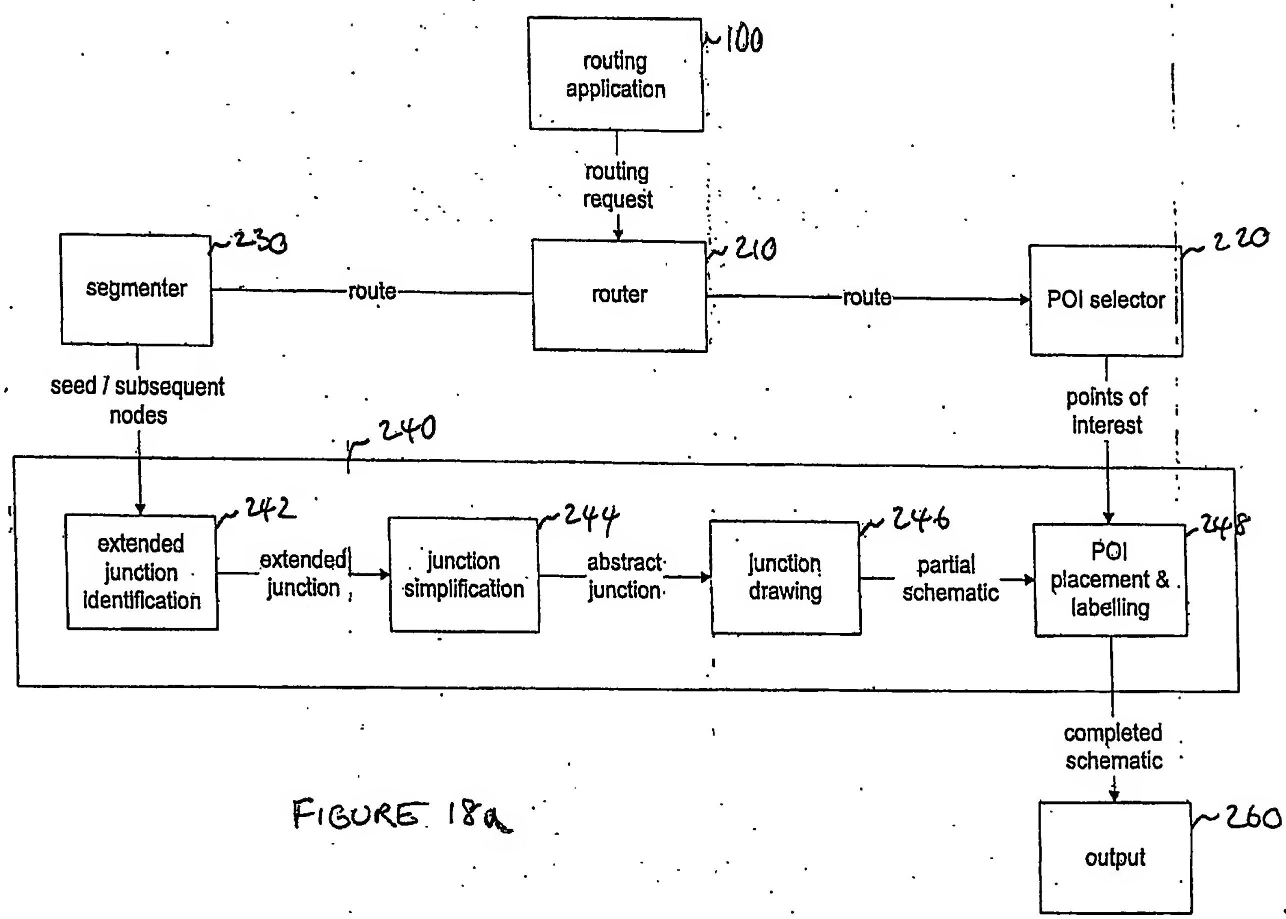

routing application
100
routing request
router
210
route
POI selector
220
segmenter
230
route
seed / subsequent nodes
points of interest
240
extended junction identification
242
extended junction
junction simplification
244
abstract junction
junction drawing
246
partial schematic
POI placement & labelling
248
completed schematic
output
260

FIGURE 18a

Fig. 18b

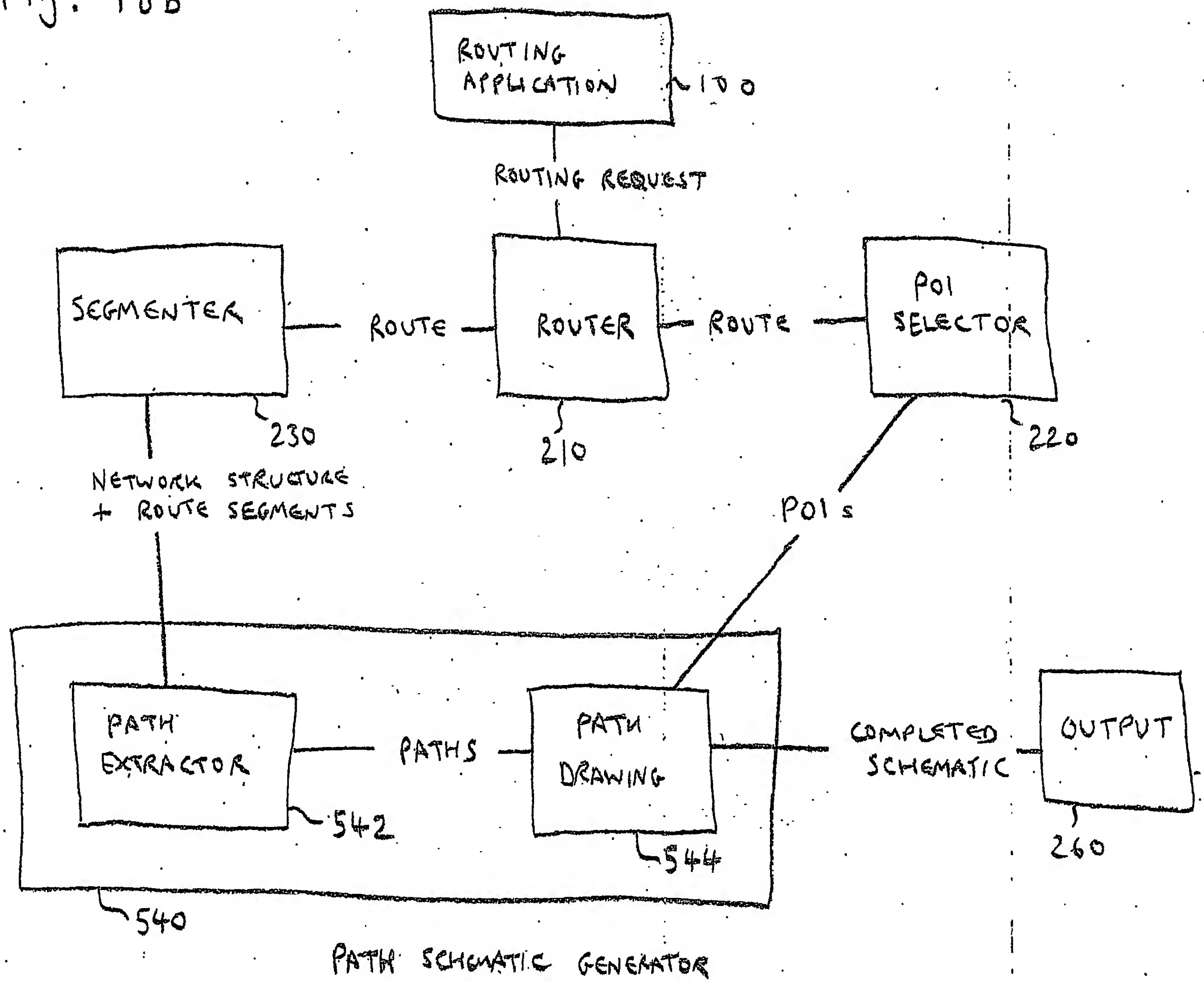
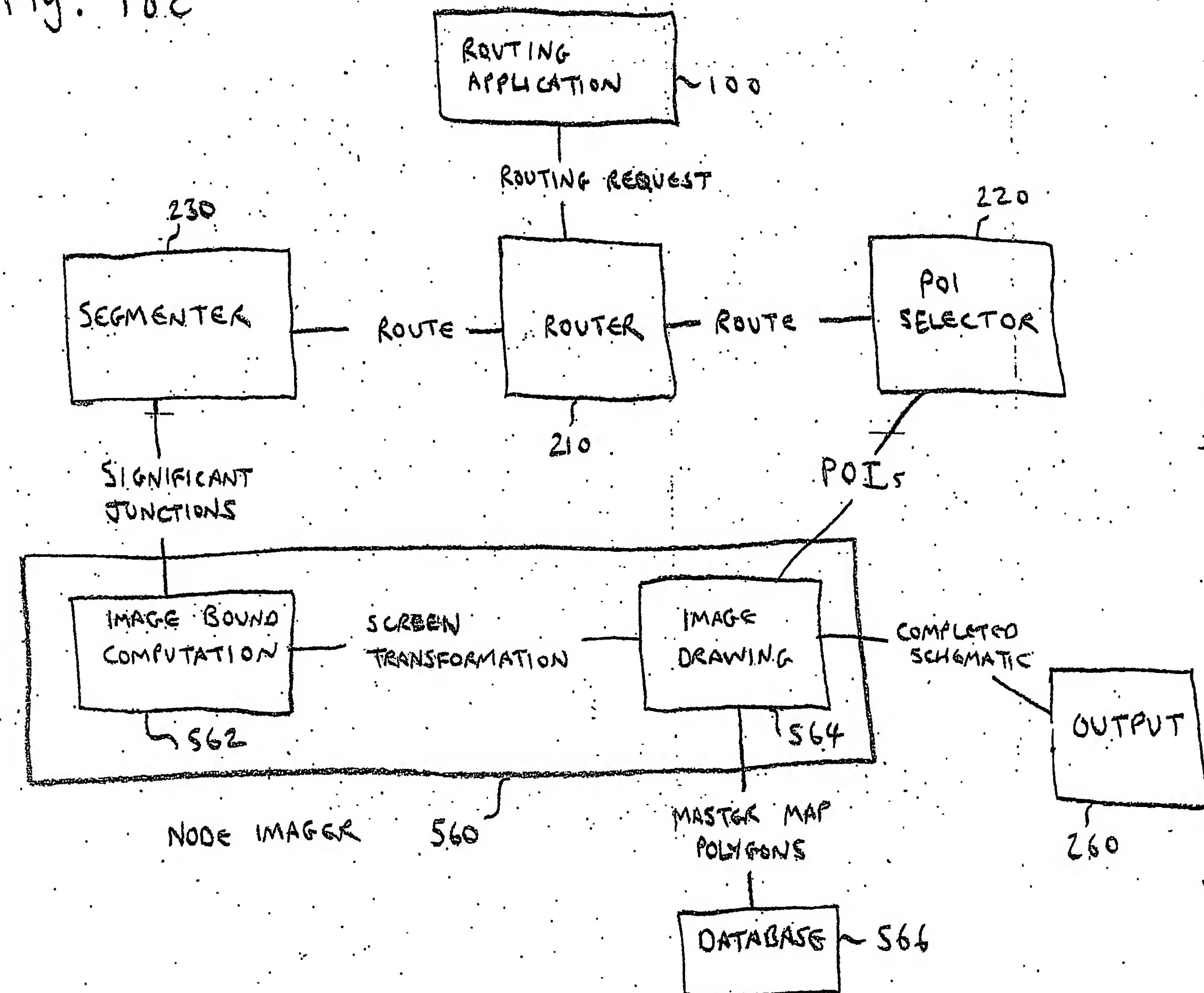

ROUTING APPLICATION
100
ROUTING REQUEST
SEGMENTER
ROUTE
ROUTER
ROUTE
POI SELECTOR
230
210
220
NETWORK STRUCTURE + ROUTE SEGMENTS
POIs
PATH EXTRACTOR
PATHS
PATH DRAWING
COMPLETED SCHEMATIC
OUTPUT
542
544
260
540
PATH SCHEMATIC GENERATOR

Fig. 18c


ROUTING APPLICATION
100
ROUTING REQUEST
ROUTER
210
ROUTE
POI SELECTOR
220
SEGMENTER
230
SIGNIFICANT JUNCTIONS
POIs
IMAGE BOUND COMPUTATION
562
SCREEN TRANSFORMATION
IMAGE DRAWING
564
COMPLETED SCHEMATIC
OUTPUT
260
NODE IMAGER
560
MASTER MAP POLYGONS
DATABASE
566

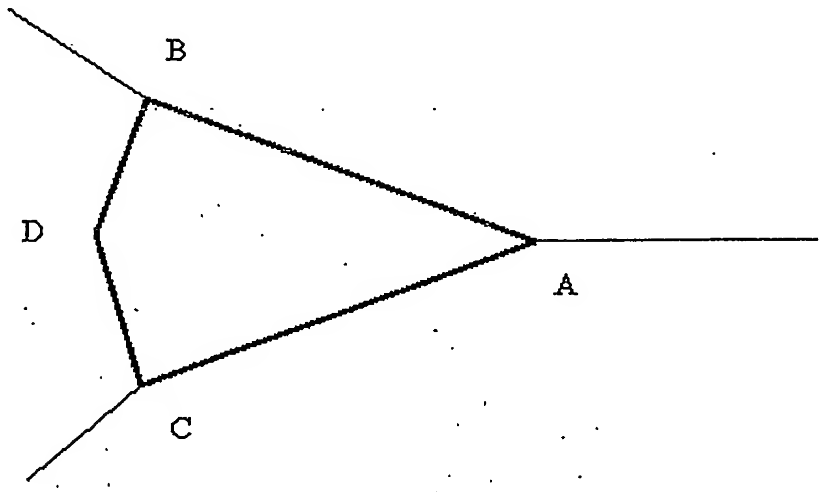


Figure 19

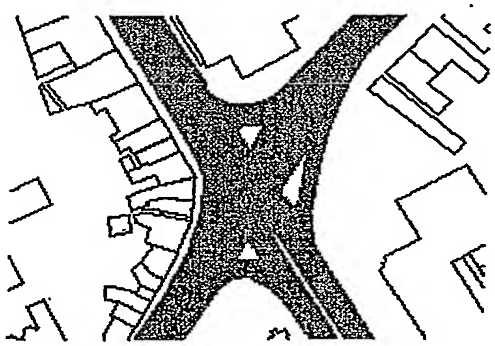


Figure 20A

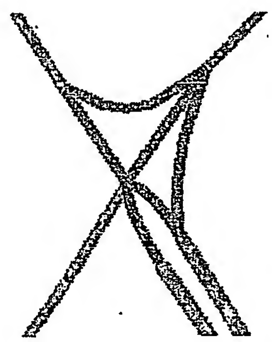


Figure 20B

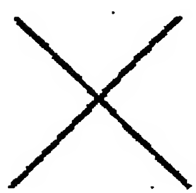


Figure 20C

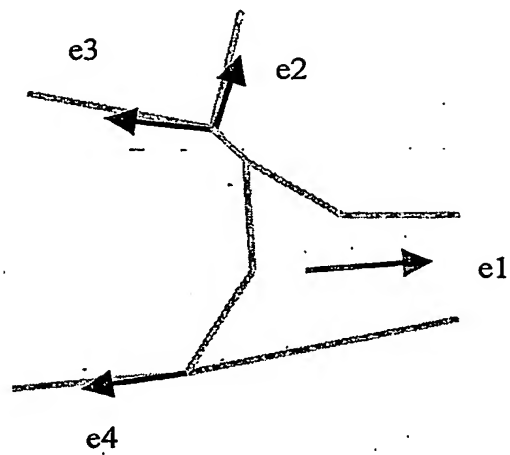


Figure 21

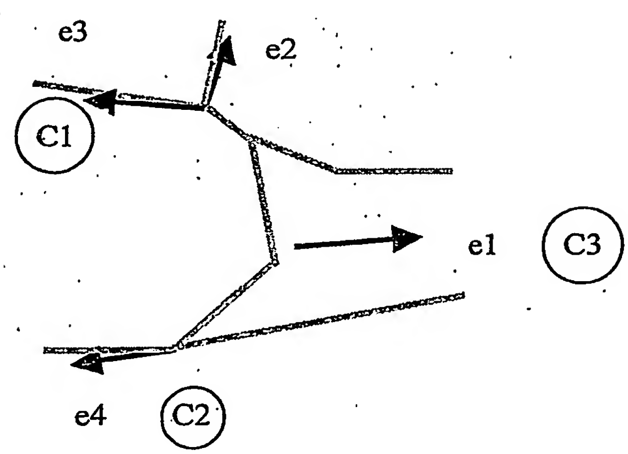


Figure 22

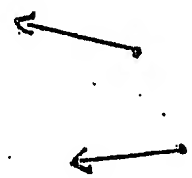


FIG. 23A

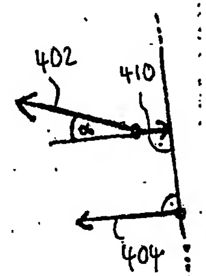


FIG. 23B

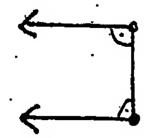


FIG 23C

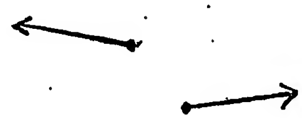


FIG 24A

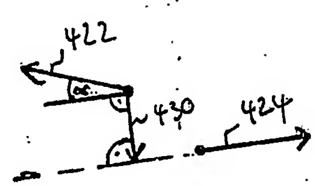


FIG. 24B

FIG. 24C

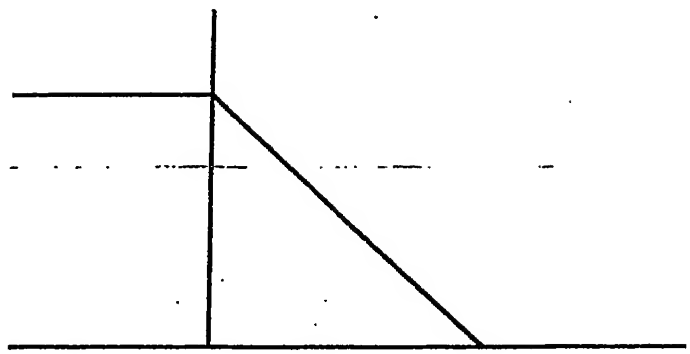


Figure 25

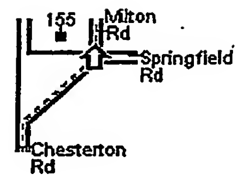


Figure 26

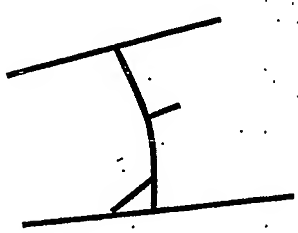


Figure 27A

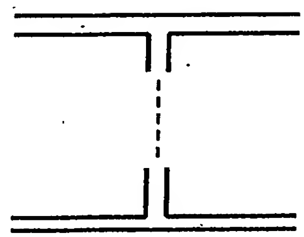


Figure 27B

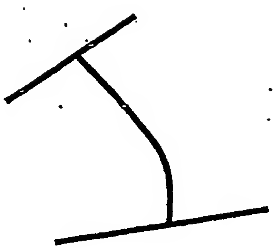


Figure 28A

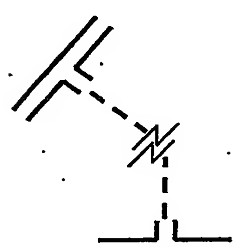


Figure 28B

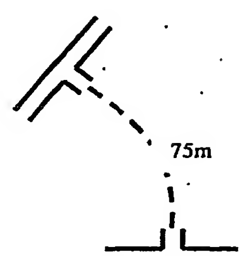


Figure 28C

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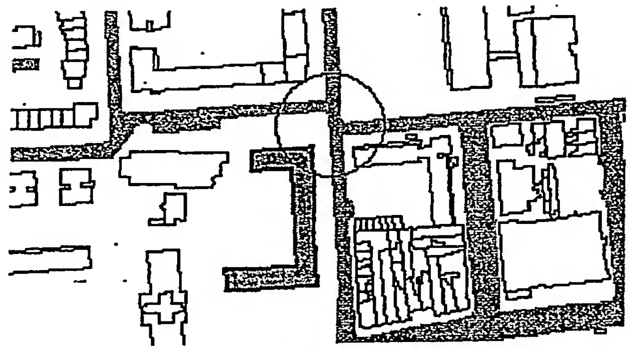

Figure 29A

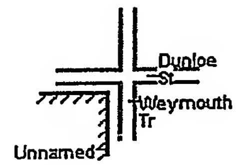

Figure 29B

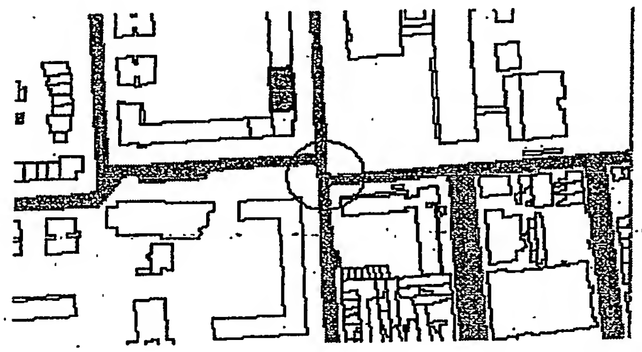

Figure 30A

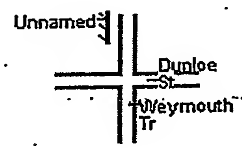

Figure 30B